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THE NEW STAR IN THE ANDROMEDA NEBULA.*

THERE are three theories of the universe, rising step by step in grandeur, on which the remarkable discovery of a new star in the Andromeda nebula throws light. Grand as is the conception of a process by which the whole of the solar system had its birth and growth, with its mighty and beneficent central sun, its families of planets of various orders, giant planets and earth-like planets, minor planets and secondary planets, with all the multitudinous orders of meteoric and cometic systems, the thought is yet more overwhelming in its grandeur that that system is itself but a unit among millions—nay, thousands of millions—of such systems. Each star is a sun, and as there are many orders of planets so are there many orders of suns. There are suns like Sirius, and Vega, and Altair, the blue-white stars, so far surpassing our own that he compares with them as Saturn or Jupiter with him, as our earth with Jupiter, or as the least of the asteroids with the earth. There are orbs again, the yellow-white stars, which are veritably our sun's brother suns, so like are they to him in structure. There are others, the orange-coloured stars, whose vaporous envelope has so far cooled as to absorb large portions of their lustre. Others yet, the red and garnet-tinted stars, are suns whose light is so darkened by their absorptive atmospheres that we must regard them as in solar decrepitude. And finally, there are bodies, the dark suns, whose light no longer penetrates their cooled envelopes; they are orbs which we cannot see, but whose existence we can occasionally trace in the perturbing influences they exert upon their nearest neighbours.

Here, then, is a system, not only grander than our solar system in this, that its components are themselves solar systems, but presenting probably a far greater variety of structure, since so many millions of bodies form those parts of it which are visible because self-luminous. We can picture to ourselves, however, a yet grander system even than this. As there are systems of solar systems—a whole galaxy of such systems—so doubtless there are systems of such galaxies. Many orders of galaxies we may conceive to exist in such a higher order of systems. Infinite must be indeed, to our conceptions, the variety prevailing among many millions of galaxies, each, like our own, containing multitudinous orders of solar systems, each of these in turn as varied as our own. We may pass even beyond the system of galaxies, and conceive with Kant the idea of systems of such systems, of systems of systems of such systems, and so on, to higher and higher orders absolutely without end. But our actual knowledge does not extend beyond the galaxy or system of solar systems; and it can never extend beyond systems of galaxies, even if it should ever extend so far.

It is on this point, indeed, that the remarkable discovery just made throws clearest light. It tells us certainly what one or two reasoners had already shown to be all but certain—that we have no evidence of galaxies external to our own. If there was one among the 5,000 known star-clouds about which it might still be plausibly maintained that it is a remote galaxy of stars, the great Andromeda nebula—"the transcendently beautiful queen of the nebulæ," as the old astronomers loved to call it—was the one. Because of its great apparent size Sir William Herschel regarded it as the nearest of the stellar nebulæ. Unlike the great irregular nebula in Orion—called, less poetically, the Fish-mouth nebula—the queen of nebulæ was not suspected of being gaseous even when Sir William Herschel adopted the belief that many nebulæ are mere masses of luminous gas or star-mist. The spectroscope in the skilful hands of Dr. Huggins had shown conclusively that the Andromeda nebula shines with such light as comes from the stars, as if it were a mighty congeries of suns.* A sudden degradation of the spectrum near the red end indicated great absorptive action by vapours surrounding this sun-like matter; and that had naturally suggested doubts as to whether the nebula can be a galaxy like our own, the leading members of which give under analysis all colours of light from the deepest red to where the spectrum faints away in darkest violet. But as one star differs from another in glory, so may one galaxy be unlike another; as there are young suns and old suns, and dying suns and dead suns, so even may galaxies be in different stages of galactic life. The arguments by which it had been shown that probably no single external galaxy is within telescope range were not based on any evidence which the telescope or the spectroscope had given about the great nebula in Andromeda considered individually, but on certain peculiarities of nebular arrangement which show that the nebulæ belong to our own stellar system. The Andromeda nebula was perhaps the one star-cloud which might possibly be an exception to this rule. It is very large, yet not resolvable into separate stars, though formed apparently of such bodies, since it gives star-light; no other nebula among all the 5,000 known to astronomers can be compared with it in this respect.

The recent discovery, however, entirely disposes of the possibility that even this great nebula can be an external galaxy. That a star of the eighth magnitude should be visible in the heart of this great cloud of star material, shows that the star-cloud cannot possibly lie at the immense distance formerly imagined as at least

* From the *Times*.

* There are, however, no dark lines in the spectrum, as I erroneously implied last week. See letters which follow.—R. P.

possible. If the Andromeda nebula were an outlying galaxy of the same size as our own, it must lie at a distance exceeding at least a hundred times that of the remotest star in our galaxy. Now the stars in the outermost part do not give one-thousandth part of the light of an eighth magnitude star. Removed a hundred times farther away those outlying stars would be reduced 10,000 times in lustre, and so would not give the 10,000,000th part of the light which comes to us from the star now shining in the Andromeda nebula. It would have to be 30,000 millions of times larger than our sun, if its surface-lustre resembled his—and it has been shown by St. Claire Deville and others that we cannot safely assume a much greater surface-lustre than our sun's to be even possible. If we admitted the sudden development of such an appallingly stupendous mass as this, the bare possibility of so wonderful a sun forming in the heart of a star-cloud would prevent our admitting the belief that that star-cloud could be a galaxy like our own. Thus the outburst of the new sun definitely negatives the belief that any external galaxies are within range of our keenest telescopic vision. The grand thought that there is a system higher than the stellar system, a system of galaxies, must remain, probably for ever, a conception—like the Kantian idea of yet higher orders of systems.

But as to the system of solar systems, the discovery just made gives positive evidence of the most interesting kind. While compelling us to draw the nebulæ back, as it were, from the remotely external position which had been assigned to them, it enhances our conceptions of the variety and vitality within the mighty system we *can* explore. Enabling us now definitely to regard all orders of nebulæ as part of our stellar system, it teaches us to see in that galaxy a complexity of structure far surpassing, as we might have anticipated, even the amazing complexity we had already recognised in the solar system. We not only see within the stellar system all the varied orders of suns, and all the wonderful varieties of arrangement among suns—double, triple, and multiple groups, clustering aggregations, streams, branches, nodules, and far-reaching clouds of suns—but we see all the varied orders of star cloudlets—globular, elliptical, ring-shaped, and spiral, resolvable and irresolvable, star dust, and star vapour—within the bounds of the same marvellously variegated system. We recognise also not only all the stages of sun-life already noted, not only the evidence of solar decay and death, but evidence of changes which imply the first stirrings of solar life. In vitality, as in variety, the great galaxy is to our conceptions infinite, even as it is infinite in extent and in duration.

The following letters have also appeared :—

"Respecting the new star in Andromeda it is announced from Brussels that at the commencement of August the stellar nucleus was not visible. Mr. Isaac W. Ward, however, reports having seen it on August 19, at 11 p.m. It was also seen at Rheims, by M. Lajoye, on August 30, and also independently by Mr. G. T. Davis, of Theale, near Reading, on September 1. The Dun Echt telescopes show it as a veritable 7½ magnitude star, with a fairly continuous spectrum. On September 3, Lord Crawford and the undersigned found that the Nova is most probably situated some 1·6s. preceding and 5″ south of the old nucleus, which is much overpowered by the light of the star. "Ralph Copeland."

"With reference to the remarkable change that has taken place in the great nebula 31 Messier in Andromeda, I was fortunate enough to obtain an observation of it last night with my 10½ inch Calver reflector. The new star was estimated at about 7·5 magnitude, orange-red in colour, and very hazy, not showing a clean disc with any power; it was followed by a most minute point of light at about twenty to thirty seconds of arc, the space between being darker and apparently devoid of nebulous matter. Whether this latter was a star or merely a 'knot' in the nebula I could not determine owing to want of light.

"A change of such magnitude in a nebula which has hitherto resisted all attempts to resolve it into stars is an event of such importance that it is to be hoped no opportunities will be lost to detect any further change that may take place, and no doubt the spectroscope will prove most valuable.

"As Mr. Knobel points out, it may be only the outbreak of one of those extraordinary variable stars of which T Coronæ (the "Blaze" star of 1866) is a good example; but I venture to think some great change has been taking place in the nebula itself, for as far back as the beginning of July I found the central portion much more condensed than usual, and so bright as almost to convey the idea of a stellar nucleus, although no absolute star point was visible. The evidence of actual change at this time, however, was not conclusive enough to warrant a public announcement. Kenneth J. Tarrant."

"I have received a memorandum on the above subject from the Rev. S. H. Saxby, of East Clevedon, Somerset, from which, by his permission, I extract some interesting particulars.

"On August 6, Mr. Saxby, who was then at Davos, observed the nebula, and remarked its singular brightness. On August 9, which was a very clear night, he examined it again, and describes it as follows:—'The whole central portion of the nebula was strikingly bright. . . . . There was no sign whatever of a stellar nucleus, nor was there anything which could so much as raise the question of the existence of one. The centre of condensation was purely nebulous, and the condensation was not abnormally rapid.' Mr. Saxby also examined the spectrum of the nebula, hoping that he might be able, on so clear a night, to detect some bright lines in it, but 'got nothing more than the usual dull, continuous spectrum, deficient at the red end,' although the nebula in Vulpecula showed its bright lines readily. The following night, August 10, gave precisely the same results.

"On returning to England Mr. Saxby examined the nebula again on Sept. 3, at 9.30 p.m., and was astonished to see a bright star in its centre, and at once communicated his discovery to me. The next morning he learned of Dr. Hartwig's prior observation of the change.

"I may add that I examined the spectrum of the new star at the Royal Observatory on Friday, Sept. 4, with the large 'half-prism' spectroscope devised by the Astronomer-Royal, and found it to be of precisely the same character as that of the nebula—*i.e.*, it was perfectly continuous, no lines, either bright or dark, being visible, and the red end was wanting. There is, therefore, at present no evidence of any outburst of heated gas, as was the case with the 'temporary' stars T Coronæ in 1866, and 'Nova' Cygni in 1876.

"The star itself was very easily seen in the finder of 3 in. aperture attached to the large refractor of the Royal Observatory. "Edward W. Maunder."

"The new star in Andromeda was observed here on Saturday and Sunday nights, Sept. 5 and 6. It is very nearly of the seventh magnitude, and of a yellow colour, similar to Arcturus, with continuous spectrum. It is

situate about twenty seconds of arc preceding and ten seconds south of the nucleus of the nebula, which, in consequence of the proximity of the new star, has ceased to be conspicuous. There is no sort of doubt that this is a new star. No star is mentioned in any of the descriptions of the nebula as existing in that position, nor shown in any of the drawings.

"Yesterday I was permitted to examine the photograph taken by Mr. Common in August, 1884, in which there is no trace whatever of the star, although the plate is covered with very much fainter stars. It was a mere chance that this interesting picture was preserved, for he regarded it as a failure because of defects of instrumental adjustment.

"It is improbable that the new star is in any way physically connected with the nebula.

"G. L. TUPMAN."

[This idea is of course disposed of now by the spectroscopic evidence, which proves beyond doubt that the star is in the midst of the nebula.—R. P.]

"Your anonymous correspondent, in the *Times* of September 8, says 'that a star of the eighth magnitude should be visible in the heart of this great cloud of star material,' &c. Again, Mr. Tarrant, in the same issue, says the star on September 4 was 'very hazy, not showing a clean disc with any power.' The inference from both these statements is that the star is to be deemed an outcome of and intimately connected with the nebula. I think it worth while to point out that, as I saw the star on September 3, my conclusions would be just the other way. I was especially struck with the remarkable sharpness of the star in my 6 in. Grubb refractor; and the conclusion forced itself irresistibly on my mind that the star was an independent outburst of light physically detached from the nebula, in front of it, and, therefore, optically projected on the nebula, but having no other connection with it. The point is one of great interest and importance, and it would be worth while to know what other observers may say. Nor did I notice the orange-red colour seen by Mr. Tarrant. However, the exhibition of such colour would in general be a ground for supposing that the star was probably a variable or temporary one, and, therefore, independent altogether of the nebula. "G. F. CHAMBERS, F.R.A.S."

"Mr. Chambers has apparently overlooked the evidence given by the spectrum of the new star. The identity of this spectrum with the characteristic spectrum of the nebula proves beyond further question that the star is physically associated with the nebula. It would have been a strange chance that a star, really much nearer, should by chance have appeared in the very heart of the most interesting nebula in the heavens, and a yet stranger chance that a new star, appearing somewhere else, should have shown the same peculiar spectrum as the Andromeda nebula; but that both these chances should be combined is altogether incredible. To this we may add that we have other reasons for regarding stars in nebulæ as physically associated with the nebulous matter amid which they seem immersed. The most wonderful variable star in the heavens, Eta Argûs, is in the very heart of the great Key-hole nebula in the keel of the star-ship Argo. Now, that star outshone in 1840 even Canopus, the second star in the heavens for splendour, and rivalled Sirius, the first. It is now barely visible on the darkest and clearest night. Imagine that nebula ten times as far away and we should have had in the outblazing of Eta Argûs the apparent formation of a new star. But the most decisive evidence was given by the new star in Cygnus in 1876, without which, indeed, the coincidence of Eta Argûs in position with the great Argo nebula might still be regarded as signifying no physical association; for that new star shone out in the midst of a nebula not before detected, but still visible in the place where that star had its short career of splendour.

"Mr. Tarrant's observation of September 3, combined with Mr. Chambers's of September 4, proves that the new star and the nebula are actively disturbed. The star's seeming change of position, if confirmed, will be worth watching.

"The sudden appearance of the new star is decidedly the most interesting astronomical discovery—or rather event, for the discovery was inevitable—since Adams and Leverrier calculated the place of the as yet unknown Neptune. It disposes finally of the theory that the nebulæ are, or may some of them be, external galaxies. Mr. Herbert Spencer, in 1859, gave three or four convincing reasons showing that the nebulæ cannot be external to our galaxy; and ten years later (not knowing of this work) I repeated those, and supplemented them with many others, and with maps of nebular distribution demonstrating to the eye that the nebulæ belong to our system. Some of these reasons and illustrative statistics I presented at a Friday evening lecture at the Royal Institution in May, 1870. The views I then urged were precisely those which the new star, regarded as physically connected with the Andromeda nebula, has made certain, and, what is more, obvious and clear to all.—Yours obediently, "RICHARD A. PROCTOR."

"Scarborough."

"SIR,—It seems at present to be improbable that the new star in the Andromeda nebula will remain visible to us very long; it has already become much fainter. Last night (Sept. 9) the star was conspicuously less bright than when first seen on Sept. 3; the total diminution of light as determined with a limiting aperture photometer being nine-tenths of a magnitude. On Sept. 4 it was four-tenths of a magnitude less bright than on Sept. 3, and on Sept. 9 the brightness had still further diminished five-tenths of a magnitude. The star is of a yellow colour, about 20″ distant from the real nucleus of the nebula, 112″ from a small star preceding it, and 228″ from a similar small star nearly south of it.

"With reference to Mr. Chambers's letter in the *Times* of to-day, I can only say that the object appears in an 8½ in. reflector distinctly star-like under all powers from 60 to 500. But in extinguishing it with the limiting aperture photometer it goes out somewhat peculiarly, which I attribute to it being superposed upon the bright ground of the nebula—the fact being that the star in that observation does not become blotted out, but only reduced to the same brightness as the luminary surface of the nebula when it becomes indistinguishable from that surface. As a matter of fact, on Sept. 9 the new star was extinguished with an aperture of 2·81 in., with the special apparatus I employ. In the monthly notices of the Royal Astronomical Society for March, 1881, I have recorded that the brightest portion of the Andromeda nebula is extinguished with an aperture of 1·95 in., using the same apparatus. This is confirmed by recent observations, suggesting that no change in the brightness of the nebula itself has taken place.

"Hence by any such photometric method it will be difficult to determine the absolute magnitude of the new star referred to an ordinary star seen on the dark background of the sky.—I am, sir, your obedient servant,

"Bocking, near Braintree." "EDWARD B. KNOBEL.

XUM

SCIENCE AND EDUCATION.*

By Sir Lyon Playfair.

VARIOUS Commissions have made inquiries and issued recommendations in regard to our public and endowed schools. The Commissions of 1861, 1864, 1868, and 1873 have expressed the strongest disapproval of the condition of our schools, and, so far as science is concerned, their state is much the same as when the Duke of Devonshire's Commission in 1873 reported in the following words:—"Considering the increasing importance of science to the material interests of the country, we cannot but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune." No doubt there are exceptional cases and some brillant examples of improvement since these words were written, but generally throughout the country teaching in science is a name rather than a reality.

The Technical Commission which reported last year can only point to three schools in Great Britain in which science is fully and adequately taught. While the Commission gives us the consolation that England is still in advance as an industrial nation, it warns us that foreign nations, which were not long ago far behind, are now making more rapid progress than this country, and will soon pass it in the race of competition unless we give increased attention to science in public education. A few of the large towns, notably Manchester, Bradford, Huddersfield, and Birmingham, are doing so.

The working classes are now receiving better instruction in science than the middle classes. The competition of actual life asserts its own conditions, for the children of the latter find increasing difficulty in obtaining employment. The cause of this lies in the fact that the schools for the middle classes have not yet adapted themselves to the needs of modern life. It is true that many of the endowed schools have been put under new schemes, but, as there is no public supervision or inspection of them, we have no knowledge as to whether they have prospered or slipped back. Many corporate schools have arisen, some of them, like Clifton, Cheltenham, and Marlborough Colleges, doing excellent educational work, though as regards all of them the public have no rights, and cannot enforce guarantees for efficiency.

A return just issued, on the motion of Sir John Lubbock shows a lamentable deficiency in science teaching in a great proportion of the endowed schools. While twelve to sixteen hours per week are devoted to classics, two to three hours are considered ample for science in a large proportion of the schools. In Scotland there are only six schools in the return which give more than two hours to science weekly, while in many schools its teaching is wholly omitted. Every other part of the kingdom stands in a better position than Scotland in relation to the science of its endowed schools.

The old traditions of education stick as firmly to schools as a limpet does to a rock; though I do the limpet injustice, for it does make excursions to seek pastures new. Are we to give up in despair because an exclusive system of classical education has resisted the assaults of such cultivated authors as Milton, Montaigne, Cowley, and Locke? There was once an enlightened Emperor of China, Chi Hwangti, who knew that his country was kept back by its exclusive devotion to the classics of Confucius and Mencius. He invited 500 of the teachers to bring their copies of these authors to Pekin, and, after giving a great banquet in their honour, he buried alive the professors along with their manuscripts in a deep pit. But Confucius and Mencius still reign supreme. I advocate milder measures, and depend for their adoption on the force of public opinion. The needs of modern life will force schools to adapt themselves to a scientific age.

Grammar-schools believe themselves to be immortal. Those curious immortals—the Struldbrugs—described by Swift, ultimately regretted their immortality because they found themselves out of touch, sympathy, and fitness with the centuries in which they lived. As there is no use clamouring for an instrument of more compass and power until we have made up our mind as to the tune, Professor Huxley, in his evidence before a Parliamentary Committee in 1884, has given a time-table for grammar schools. He demands that, out of their forty hours for public and private study, ten should be given to modern languages and history, eight to arithmetic and mathematics, six to science, and two to geography, thus leaving fourteen hours to the dead languages.

No time-table would, however, be suitable to all schools. The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture. Even now they introduce into their curriculum subjects unknown to them when the Royal Commission of 1868 reported, though they still accept science with timidity. Unfortunately, the other grammar-schools which educate the middle classes look to the higher public schools as a type to which they should conform, although their functions are so different. It is in the interest of the higher public schools that this difference should be recognised, so that, while they give an all-round education and expand their curriculum by a freer recognition of the value of science as an educational power in developing the faculties of the upper classes, the schools for the middle classes should adapt themselves to the needs of their existence, and not keep up a slavish imitation of schools with a different function.

The stock argument againt the introduction of modern subjects into grammar-schools is that it is better to teach Latin and Greek thoroughly rather than various subjects less completely. But is it true that thoroughness in teaching dead languages is the result of an exclusive system? In 1868 the Royal Commission stated that even in the few great public schools thoroughness was only given to 30 per cent. of the scholars, at the sacrifice of 70 per cent. who got little benefit from the system. Since then the curriculum has been widened and the teaching has improved. I question the soundness of the principle that it is better to limit the attention of the pupils mainly to Latin and Greek, highly as I value their educational power to a certain order of minds. As in biology the bodily development of animals is from the general to the special, so is it in the mental development of man. In the school a boy should be aided to discover the class of knowledge that is best suited for his mental capacities, so that, in the upper forms of the school and in the university, knowledge may be specialised in order to cultivate the powers of the man to their fullest extent. Shakespeare's educational formula may not be altogether true, but it contains a broad basis of truth—

> "No profit goes, where is no pleasure ta'en;—
> In brief, Sir, study what you most affect."

The comparative failure of the modern side of school education arises from constituting it out of the boys who are looked upon as classical asses. Milton pointed out

* From the opening address at the meeting of the British Association.

that in all schools there are boys to whom the dead languages are "like thorns and thistles," which form a poor nourishment even for asses. If teachers looked upon these classical asses as beings who might receive mental nurture according to their nature, much higher results would follow the bifurcation of our schools. Saul went out to look for asses and he found a kingdom. Surely this fact is more encouraging than the example of Gideon, who "took thorns of the wilderness and briers, and with these he taught the men of Succoth. (Judges viii., 16.) The adaptation of public schools to a scientific age does not involve a contest as to whether science or classics shall prevail, for both are indispensable to true education. The real question is whether schools will undertake the duty of moulding the minds of boys according to their mental varieties. Classics, from their structural perfection and power of awakening dormant faculties, have claims to precedence in education, but they have none to a practical monopoly. It is by claiming the latter that teachers sacrifice mental receptivity to a Procrustean uniformity.

The universities are changing their traditions more rapidly than the schools. The *via antiqua* which leads to them is still broad, though a *via moderna*, with branching avenues, is also open to their honours and emoluments. Physical science, which was once neglected, is now encouraged at the universities.

As to the seventy per cent. of boys who leave schools for life-work without going through the universities, are there no growing signs of discontent which must force a change? The Civil Service, the learned professions, as well as the army and navy, are now barred by examinations. Do the boys of our public schools easily leap over the bars, although some of them have lately been lowered so as to suit the schools? So difficult are these bars to scholars that crammers take them in hand before they attempt to leap; and this occurs in spite of the large value attached to the dead languages and the small value placed on modern subjects. Thus, in the Indian Civil Service examinations, 800 marks as a *maximum* are assigned to Latin, 600 to Greek, 500 to chemistry, and 300 to each of the other physical sciences. But if we take the average working of the system for the last four years, we find that while 68 per cent. of the *maximum* were given to candidates in Greek and Latin, only 45 per cent. were accorded to candidates in chemistry, and but 30 per cent. to the other physical sciences. Schools sending up boys for competition naturally shun subjects which are dealt with so hardly and so heavily handicapped by the State.

Passing from learned or public professions to commerce, how is it that in our great commercial centres, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth and take the places of profit which belong to them by national inheritance? How is it that in our colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they orginated, in order to engraft themselves abroad, although their decaying roots remain at home? The answer to these questions is that our systems of education are still too narrow for the increasing struggle of life. Faraday, who had no narrow views in regard to education, deplored the future of our youth in the competition of the world, because, as he said with sadness, "our schoolboys, when they come out of school, are ignorant of their ignorance at the end of all that education."

The opponents of science education allege that it is not adapted for mental development, because scientific facts are often disjointed and exercise only the memory. Those who argue thus do not know what science is. No doubt an ignorant or half-informed teacher may present science as an accumulation of unconnected facts. At all times and in all subjects there are teachers without æsthetical or philosophical capacity—men who can only see carbonate of lime in a statue by Phidias or Praxiteles; who cannot survey zoology on account of its millions of species, or botany because of its 130,000 distinct plants; men who can look at a tree without getting a conception of a forest, and cannot distinguish a stately edifice from its bricks. To teach in that fashion is like going to the tree of science with its glorious fruit in order to pick up a handful of the dry fallen leaves from the ground.

It is, however, true that as science teaching has had less lengthened experience than that of literature, its methods of instruction are not so matured. Scientific and literary teaching have different methods, for while the teacher of literature rests on authority and on books for his guidance, the teacher of science discards authority and depends on facts at first hand, and on the book of Nature for their interpretation. Natural science more and more resolves itself into the teaching of the laboratory. In this way it can be used as a powerful means of quickening observation, and of creating a faculty of induction after the manner of Zadig, the Babylonian described by Voltaire. Thus facts become surrounded by scientific conceptions, and are subordinated to order and law. It is not those who desire to unite literature with science who degrade education; the degradation is the consequence of the refusal.*

A violent reaction—too violent to be wise—has lately taken place against classical education in France, where their own vernacular occupies the position of dead languages, while Latin and science are given the same time in the curriculum. In England manufacturers cry out for technical education, in which classical culture shall be excluded. In the schools of the middle classes science rather than technics is needed, because when the seeds of science are sown, technics as its fruit will appear at the appointed time. Epictetus was wise when he told us to observe that though sheep eat grass, it is not grass but wool that grows on their backs.

Should, however, our grammar schools persist in their refusal to adapt themselves to the needs of a scientific age, England must follow the example of other European nations, and found new modern schools in competition with them. For, as Huxley has put it, we cannot continue in this age of "full modern artillery to turn out our boys to do battle in it, equipped only with the sword and shield of an ancient gladiator." In a scientific and keenly competitive age an exclusive education in the dead languages is a perplexing anomaly. The flowers of literature should be cultivated and gathered, though it is not wise to send men into our fields of industry to gather the harvest when they have been taught only to cull the poppies and to push aside the wheat.

The widening of the bounds of knowledge, literary or scientific, is the crowning glory of university life. Germany unites the functions of teaching and research in the universities, while France keeps them in separate institutions. The former system is best adapted to our habits, but its condition for success is that our

* This remark may be read both ways. There are students of science foolish enough to refuse from their side.—R. P.

science chairs shall be greatly increased, so that teachers should not be wholly absorbed in the duties of instruction. Germany subdivides the sciences into various chairs, and gives to the professors special laboratories. It also makes it a condition for the higher honours of a university that the candidates shall give proof of their ability to make original researches. Under such a system, teaching and investigation are not incompatible. In the evidence before the Science Commission many opinions were given that scientific men engaged in research should not be burdened with the duties of education, and there is much to be said in support of this view when a single professor for the whole range of a physical science is its only representative in a university. But I hope that such a system will not long continue, for if it does we must occupy a very inferior position as a nation in the intellectual competition of Europe. Research and education in limited branches of higher knowledge are not incompatible. It is true that Galileo complained of the burden imposed upon him by his numerous astronomical pupils, though few other philosophers have echoed this complaint. Newton, who produced order in worlds, and Dalton, who brought atoms under the reign of order and number, rejoiced in their pupils. Lalande spread astronomers as Liebig spread chemists and Johannes Müller biologists, all over the world. Laplace, La Grange, Dulong, Gay Lussac, Berthollet, and Dumas were professors as well as discoverers in France. In England our discoverers have generally been teachers; in fact, I recollect only three notable examples of men who were not—Boyle, Cavendish, and Joule. It was so in ancient as well as in modern times, for Plato and Aristotle taught and philosophised. If you do not make the investigator a schoolmaster, as Dalton was, and as practically our professors are at the present time, with the duty of teaching all branches of their sciences, the mere elementary truths, as well as the highest generalisations, being compressed into a course, it is well that they should be brought into contact with the world in which they live, so as to know its wants and aspirations. They could then quicken the pregnant minds around them, and extend to others their own power and love of research. Goethe had a fine perception of this when he wrote—

> Wer in der Weltgeschichte lebt,
> Wer in die Zeiten schaut, und strebt,
> Nur der ist werth, zu sprechen und zu dichten.

THE PHILOSOPHY OF CLOTHING.

By W. Mattieu Williams.

XVII.—SHOES AND RUNNING.

I HAVE to congratulate the Editor on his escape from a volley of correspondence controverting my last paper. It may be that those who would otherwise have fired at it are at this season better employed—are practically protesting by making pedestrian excursions in the exceptionally thick-soled boots which all *occasional* pedestrians find so advantageous. My own experience agrees with theirs. I have found that, towards the end of a walk of ten or twelve hours' duration with thin shoes, the soles of my feet have ached miserably, and that this peculiar aching was not suffered if thick-soled, hob-nailed boots were worn. Sportsmen (I mean those who hunt wild birds or beasts in wild regions, not poultry-yard battue-butchers) record similar experience.

How, then, are these facts to be reconciled with the principles expounded in my last? I admit the difficulty, but do not give it up as a hopeless paradox. Other facts, other experiences supply explanatory data. In the course of my wanderings I have met many tramps and others who live afoot. The demand for thick-soled boots does not present itself in their case. Some of the tramps were barefooted or thinly shod from necessity, but not all, as I have frequently seen them walking barefooted or in thin shoes, and carrying a stout pair of boots on their backs. This especially in Germany and Switzerland.

I observed an instructive difference in the foot-gear in different parts of Norway. Usually the roads are excellent, and the poorest peasant "keeps his carriage." Thick boots are common where this is the case; but there are exceptional regions that are roadless, where even a carriole cannot travel. The Jotunhjem, the Justedal, and some parts of Tellemarken are examples of this. The owners of these mountains, valleys and glaciers are lithe and much-enduring habitual pedestrians. They rarely go barefooted, and then for climbing rather than walking; but they wear shoes made as light as economy permits.

A very useful form of home-made shoe is worn in the Justedal. It is shaped like those of our "Oxonian" pattern that lace in front, but the lace extends all round, under the ankle and above the heel, being threaded along the upper part of the shoe close to its edge by running it through holes so that it passes alternately inside and outside. The leather being soft and pliable the shoe is thus drawn like the mouth of a bag close round, leaving no space for the entry of pebbles, &c. Though lightly made, these shoes hold very firmly to the feet.

Putting these facts together, we may infer that the demand for thick-soled boots by occasional pedestrians is due to an abnormal tenderness or weakness of the foot induced by habitual sedentary life and swaddling of the feet. My own sensations indicate that this particular weakness resides in the ligaments that hold the bones of the tarsus together, and that it is analogous to the weakness of ankle which creates a demand for the support of laced-up boots. I have felt it the most acutely on the first few days of a pedestrian excursion, very little towards the end of a long one, and have found that the best remedy is to bare the feet and hold them as long as possible in cold water. It is well known that this is the best remedy for a sprain or strain of the ligaments of the ankle, and I may add, by way of advice to all who are troubled with weak ankles, that instead of making them weaker by the artificial support of laced boots, they may, with patience and care, strengthen them considerably by habitually wearing shoes rather than boots, and as frequently as possible bathing the ankles with cold water. The reaction after the cold water brings a supply of blood to the part, and evidently nourishes the ligaments, especially the surrounding strap that binds and holds in their place the tendons descending from the leg muscles.

I may here mention a small invention of my own, which is useful. Instead of using ordinary shoe-strings to ordinary shoes, I lace a piece of rather strong "elastic" (the india-rubber braid sold by drapers under this name) through the holes, and knot it. The shoe may then be slipped on or off without any tying or untying.

Another successful experiment which I have tried as a pedestrian, is that of having shoes made reversible, both alike, so that if any local chafing occurs to make any part of either foot at all sore, the shoes may be reversed. This usually affords immediate relief. Besides this, all one-sided wearing by treading over is prevented by reversing daily.

It is, however, rather difficult to obtain such straight shoes. Shoemakers, though remarkably Radical in politics, are very Conservative in all that concerns their own trade, and not easily taught to carry out trade innovations. In such shoes the additional width demanded is chiefly across the middle or widest part of the sole. When this is given the large toe finds room for itself by pushing the foot outwards to the extreme limit of this extra sole breadth. Low broad heels are of course demanded in these, as in all other shoes.

It may be expected that I should say something to women of fashion about the ridiculous high heels they have lately worn for fashion's sake. Of course, I could show how unnaturally these instruments of torture strain certain muscles and paralyse others, how injurious they are to health and subversive of proper exercise, but in doing this I should be reasoning as though to rational beings, should be assuming that the people addressed are endowed with a respectable amount of intelligence, and amenable to proper motives. I beg to assure my readers that I am subject to no such delusion, have lived long enough and have seen enough of mankind and of womankind to make no such false estimate of character.

In direct contradiction to the demand of the occasional pedestrians for thick-soled and ankle-laced boots is that of *running* athletes. They are, so far as I am able to learn, unanimous in favour of very light, soft, porous, and pliable shoes. Those sold under the name of "running shoes" make an approach nearer to physiological requirements than any others commonly offered for sale. They have no raised heels, are as light, soft, and thin as is possible in affording the required protection and grip. The foot is nearly as free as if bared.

Recent observations and reflection have led me to conclude that all civilised European nations are going wrong in their habits of locomotion. We walk too much and run too little. If a man has to cover twenty miles in five hours he should not walk at the rate of four miles an hour, but should rather make the journey by alternately trotting a piece at five miles an hour and then walking about the same distance at three miles an hour. I am now convinced that fast walking is questionable or even bad exercise, and that daily discipline in gentle trotting is very desirable, our general muscular structure being better adapted for running than for the straining effort of rapid walking. A child runs spontaneously; so do men who are unrestrained by conventionality, and all enjoyable athletic games (excepting the solemn golf of serious Scotchmen, and fashionable archery) involve more or less of running.

I profoundly regret that I did not make this discovery thirty years earlier. Had I done so my present girth would be very different. One of my recent neighbours was a Hindoo rajah. This gentleman carried out a daily discipline of running a few miles—usually on the Harrow-road. On ordinary occasions he took a trot from his house and back again; at other times, as when driving to town, he ran behind his carriage. Judging from his physical appearance. he kept himself in excellent condition thereby. We should all do well to follow his example. The Rotten-row would be a still more useful institution than at present if, in addition to the soft-ground horse-way, there were a foot-track for gentlemen trotters in flannel whites, and ladies in corresponding divided skirts. Even from a spectators' point of view the interest of that popular show would be increased thereby. It would be well if all the members of the Pall-mall clubs took a trot round the Mall and Birdcage-walk preparatory to the house dinner. Members of Parliament the same. For the barristers, attorneys, and their clients, Lincoln's-inn Fields are available when the court rises. City men might run to and from the station daily instead of walking. In the country there is no difficulty.

It is very satisfactory to observe that athleticism is so rapidly superseding the dandyism of the past. One of its admirable forms is the organisation of "harriers," a party or club of youths who start rationally dressed for a ten or fifteen or twenty miles' run, and meet convivially at the end; provided always that beer and tobacco are not allowed to neutralise the benefits of the fresh air and exercise.

I need scarcely add after the above that canvas or other strong porous material is incomparably preferable to leather for the upper part of shoes. The demand for waterproof foot-covering due to that morbid condition of the feet described in my last, may be superseded by gradually releasing the feet from excess of bandage and exposing and expanding them naturally. A certain cure for "cold feet" is obtainable by frequently immersing them in cold water for a short time, then taking a sharp walk or run in thin shoes. Perseverance in this will in due time remove all real and imaginary danger of taking cold as a consequence of wet feet.

MYSTERIES AND MORALITIES.

By Edward Clodd.

VII.

THESE several pageants from the Apocryphal Gospels lead up to the most popular, because farcical, pageants of the Adoration of the Shepherds, which are common to the four series, the Towneley having two plays on the subject.

In the first of these, *Prima Pastorum*, two shepherds complain—one of the loss of his sheep, and the other of dangers from "robers" and "bosters"; when a third joins them, and, finding them quarrelling about the pasture-land, chaffs them at losing sight of the sheep. They then fraternise, and empty their bags, one bringing out, with "mustard afore," a cow's foot, a pig's leg, "two blodynges (black puddings), I trow, a leveryng (liver) betwene"; another producing "an ox-tayle," a "good py," and "two swyne gronys"; while Tercius Pastor contributes "the leg of a goys," with chekyn's endorde,* pork, partryk," and other delicacies, which they wash down with "good halsom aylle of Kely,"† this caution being given:—

> Bewar now, I wynk,
> For and thou drink drely in thy polle wylle it synk;

but unheeded, for says

> *Tercius Pastor.* Be my dam soulle, Alyce, it was sadly dronken.
> *Primus Pastor.* Now, as ever have I blys, to the botham it is sonken.

They then seek sleep, and just as the third shepherd utters this odd invocation,

> Jesus O' Nazorus,
> Crucyefixus;
> Marcus, Andreas,
> God be our spede!

they hear the angel's announcement of the birth of Jesus, the prophecies about whom they recite, the third

* A term used in cookery, said to mean *gilt over.*
† Query, Hely, *i.e.*, Ely.

shepherd capping the rest by quoting, not very correctly, and transposing the lines from Virgil:—

Jam nova progenies cœlo demittitur alto,
Jam rediet virgo, redeunt Saturnia regna.*

Against which such veneer of learning John Horne, the second shepherd, protests:—

What speke ye here in myn eeres?
Telle us no clerge, I hold you of the freres, (friars)
It semys by youre Laton
Ye have lerd youre Caton.†

They then repair to Bedleme (Bethlehem), and present their gifts to the babe; one offering him a box "this lytylle spruce cofer;" the second offering him a ball, saying,

Haylle, lytylle tyne mop!
Rewarder of mede!
Haylle, bot oone drop of grace at my nede;
Haylle, lytylle mylk sop! haylle David sede!
Of our crede thou art crop,‡ haylle, in God hede!§

The third shepherd gives him a bottle, and Mary having bestowed her blessing, they depart.

In the York play, which has only fourteen stanzas, the shepherds, after hastening to find their fee,‖ are startled by the angels' "noble noyse," and repair to Bethlehem, where they find the "lorde layde betwyxe tuo bestis tame," and offer him respectively a "broche by a belle of tynne at youre bosom to be;" "tuo cobill notis (cobb-nuts) uppon a bande" (ribbon); and "an horne spone that will herbar (hold) fourty pese."

In the Chester pageant *De Pastoribus greges pascentibus*, dramatic propriety is scattered to the winds, the angel's appearance is made occasion of great fun, his pronunciation of "gloria" is discussed, the shepherds, rough Cheshire or Lancashire men, refresh themselves with jannocks (oatmeal-bread) of Lancashire, butter of Blacon, cheese, and Halton ale, quarrel and fight, and then at the appearance of the Star in the East, hie to Bethlehem, where one of them, Trowle, gives Jesus "a pair of his wife's old hose," and of three boys who follow them with offerings, one gives his nuthook, so that

To pulle doun apples, pears, and plombes,
Old Joseph shall not need to hurt his thombes.

The Coventry play is the most featureless of the four, being filled in the main with the shepherds metrical recital of the Messianic prophecies and adoration of the "babe and barne of blys."

But it is in the second play of the Towneley Series, *Secunda Pastorum*, that the comic element reaches its climax, not without value, however, in the rude yet faithful picture of old country-life set before us. As in the first play, the shepherds in turn tell their troubles; one grumbling at the cold and the taxes (they "ar fortaxed and ramyd," *i.e.*, wrongly taxed and over-reached); a second about his wife and marriage generally. Of the former he says she is—

As sharp as thystylle, as rugh as a brere,
She is browyd lyke a brystylle, with a sowre loten chere;
Had she ones wett her whystyll she couthe syng fulle clere
Hyr pater noster.
She is as greatt as a whalle,
She has a galon of galle,
By hym that dyed for us alle!

And of the latter:—

But yong men of wouyng, for God that you boght,
Be welle war of wedying, and thynk in youre thoght
"Had I wyst" is a thing it servys of noght;
For thou may cache in an owre
That shalle savour fulle sowre
As long as thou lyffys.

They are joined by a third shepherd, who complains of the floods, hard work, and low wages, these last in arrears as well; after which they seek to forget their sorrows in a song, the first agreeing to "syng the tenory," the second to "tryble so hye," and the third "the meyne," when they are interrupted by the arrival of one Mak, at whom they look askance as a man suspected of sheep-stealing, and scruple not to tell him so. After supper, and gossip about Mak's wife—

Ilk yere that commes to man
She brynges furthe a lakan,
And some yeres tuo.

They all lie down to sleep, putting him between them. After this invocation:

Fro my top to my too
Manus tuas commendo
Poncio Pilato,
Cryst crosse me spede,

Mak contrives while they are snoring, to slink off with sheep on his back. Hurrying home, he knocks up his wife, when they put their wits together how best to hide the theft, and she suggests popping the sheep in the cradle and figuring lying-in. Mak agrees:

Thou red;
And I shall say thou was lyght
Of a knave childe this nyght.

He then returns to the shepherds, who have not missed him, but when they wake, tell dreams about him, that he was clothed in a wolf's skin, that he had "trapt a fatt shepe." Mak meanwhile shams sound sleep, and when roused, says he dreamed that his wife had given birth to a "yong lad," and that he must hurry home. Missing the sheep, they follow him, and clamour at the door, when he begs them

speke soft
Over a seke woman's heede.

They charge him with the robbery, which both Mak and his wife deny, she saying through her groans.—

I swelt (die)
Outt, theyfys, fro my wonys! (dwelling)
Ye com to rob us for the nonys.
Mak. Here ye not how she gronys?
Your hartys should melt.

At last, after looking about for signs of mutton, they give up the search, when, just as Mak is bidding them farewell, one of the shepherds says to another:—

Primus Pastor. Gaf ye the chyld anything?
Secundus Pastor. I trow not oone farthying.
Tercius Pastor. Fast agayne wille I flyng,
Abyde ye me there.
Mak, take it to no grefe, if I com to thi barne.
Mak. Nay, thou does me greatt reprefe (reproof) and fowle has thou farne.
Tercius Pastor. The childe wille it not grefe, that lytylle day starne.
Mak, with your lefe, let me gyf youre barne
Bot vj pence.
Mak. Nay, do way; he slepys.
Tercius Pastor. Me thynk he pepys.
Mak. When he wakyns he wepys.
I pray you go hence.
Tercius Pastor. Gyf me lefe hym to kys and lyft up the clowtt.
What the deville is this? he has a long snowte.
Secundus Pastor. He is lyke to owre shepe.
Tercius Pastor. Wylle ye se how thay swedylle
His foure feytt in the medylle

---

* Jam redit et virgo redeunt Saturnia regna;
Jam nova progenies cælo demittitur alto.
Eclog. iv., 6, 7.

† The *Disticha Catonis*, an introductory book then used in teaching Latin.

‡ Upper branch.

§ *Towneley Mysteries*, p. 96.

‖ A. S. *feoh*, cattle, property; cognate with Sanskrit *paçu*, Latin *pecus*, cattle, which first signifying flocks, gradually came to mean property in money or kind.

Sagh I never in a credylle
A hornyd lad or now.

Mak. Peasse byd I: what! lette be youre fare;
I am he that hym gatt and yond woman hym bare.

The wife also tries to brazen it out:—

A pratty child is he
As syttes on a woman's kne;
A dylly downe, perde,
To gar a man laghe.

Tercius Pastor. I know him by the eere marke: that is a good tokyn.

Mak. I telle you, syrs, hark, his noys was broken.
Sythen told me a clerk that he was forspokyn (bewitched).

Primus Pastor. This is a false wark. I wold fayn be wrokyn (revenged)
Get wepyn.

Wife. He was takyn with an elfe;
I saw it myself
When the clok stroke twelf
Was he forshapyn (transformed.*)

At last Mak gets thrashed for the theft, and the weary shepherd's rest is broken by the "Gloria in Excelsis" of the angels, of whose singing they make fun. The play concludes with the visit to Bethlehem, and the presentation to the infant Jesus of "a bob of cherys," a "byrd," and a "balle" wherewith to play "tenys."

Among the skilful imitations of Mystery Plays the *Nativity*, in Longfellow's *Golden Legend*, and the *Prologue in Heaven* in *Faust* may be mentioned. In this last-named drama Goethe has reproduced with truth and vigour the ancient conceptions of the relations between God and the archfiend, of which both the Mysteries and Moralities give so vivid a picture.

THE GREAT RED SPOT ON JUPITER.

By RICHARD A. PROCTOR.

(*Continued from p.* 200.)

LESS simple, but not less decisive is the mathematical evidence adduced by Professor Geo. H. Darwin (son of Charles Darwin), who has shown that the movements of Jupiter's satellites would be other than they are if the mass of Jupiter were distributed uniformly, or with any approach to uniformity, throughout the globe we measure as Jupiter's. Either there must be great compression towards the centre of Jupiter's globe, or the outer parts of the region within the cloud surface we measure must be of very small density, the real globe beginning thousands of miles inside that envelope.

I pass over for the moment the powerful argument derivable from the behaviour of Jupiter's satellites. But I must say that, in my opinion, when observers of great skill, like the late Admiral Smyth, Sir Thomas Maclear, Professor Pearson, Mr. Todd of Adelaide, Mr. Ellery of Melbourne, and the assistants of these last-named observers, record observations, such as the reappearance of a satellite after its transit across Jupiter's disc had already begun, and the visibility of a satellite when behind the planet and well within the disc, and the visibility of a faint star through the outer envelopes of Jupiter, it seems to me idle to advance optical-illusion interpretations such as would barely avail to explain such phenomena recorded by the merest beginners with the telescope. Thus Mr. Todd, Government Observer at Adelaide, who has had more experience than any man living in observing transits and occultations of Jupiter's satellites (having specially devoted himself to the work, in response to an appeal of Sir George Airy's), records that on four occasions he saw a satellite pass behind the well-defined edge of the planet, the form of the satellite continuing visible, without distortion, until at last the whole satellite was thus seen through the outer parts of the planet, and that on each occasion his assistant, a very cautious and well-practised observer, saw the same phenomenon. Reply is made that possibly Jupiter was a little out of focus, or his outline for some other reason indistinct, and the satellite not really seen within it, or possibly the observers (both of them!) mistook a false image of the satellite, the result of wearied eye, for the satellite itself. Surely we may say that such an explanation is inconsistent with all reasonable probabilities. A mere beginner in observation may have the edge of the planet out of focus, and suppose the blurred extension so produced to represent the real dimensions of the planet. But Mr. Todd is no mere beginner; he is an "old hand," and an old hand at this particular work. His assistant, again, is no beginner, but a practised observer. In hazy weather, again, even a practised observer might form an unsatisfactory estimate of the position of Jupiter's edge (though he would by no means see a clearly-defined outline to the satellite); but the weather was not hazy; the sky was exceptionally clear and still (so Mr. Todd told me when I had the pleasure of meeting him at Adelaide in 1880). The wearied-eye theory would be quite out of the question in the case of a single observer of any skill; but when Mr. Todd, seeing the outline of the satellite through the outskirts of the planet, called his assistant to take his place at the telescope, there was no wearied eye with a false image of the satellite on it, at work, but a fresh eye, which had not been looking at a satellite of Jupiter's for some time; and when Mr. Todd resumed his place at the telescope, his eye too was practically a fresh one. So with other recorded cases, where skilful and well-practised eyes have observed phenomena which can only be explained by recognising great tenuity in the outer cloud-laden regions of Jupiter, and a great extension of his gaseous surroundings in depth.

We seem to have travelled a long way from the great red spot, but in reality all that we have been inquiring into since we left the spot bears importantly on our interpretation of that remarkable phenomenon:

When we see so many independent lines of evidence all pointing to the conclusion that that state of things prevails to which the only valid explanation of the shape of the great red spot had already led us, all reasonable doubt seems removed. We may rest assured, I think, that the red spot really owed its symmetry of form to the central nature of the forces at work in forming it, and its elongated shape to the circumstance that regions at very different distances from the planet's centre took part in forming the spot, uprising matter being left lagging westwards and down-sinking matter being hurried forwards eastwards, instead of travelling with uniform velocities from the centre of disturbance.

But now, as soon as we thus recognise a region below the visible surface of the planet as taking part in the disturbance indicated by the great spot, it is a natural thought that possibly the origin of the whole disturbance was not only below the visible surface of Jupiter, but in

* In the *Minstrelsy of the Scottish Bards*, iii., 479, is a balladised Eskdale tradition of Archie Armstrong having stolen a sheep and placed it in a cradle, and by pretending that it was a child, deceiving those who came in pursuit of him and it. It is clear from the above that the story is much older than the time of Charles the First's banished jester. Note in Collier's *Hist. Dram. Poetry*, II., 107.

the real globe of the planet. Let us see whether this idea leads us to any results which seem to correspond with the phenomena actually presented by the great spot.

If the origin of the disturbance were in the real globe of Jupiter, then it must be presumed that the original disturbance was due to the intense heat pervading the whole frame of the planet and was explosive in character. An outburst of compressed vapour from some gigantic volcano on Jupiter, carrying upwards vast vaporous masses to regions of much diminished pressure, would be followed by the rapid rush outwards of the expanding vapour, and by the sweeping away of the cloud masses which before had covered the region of disturbance, over an immense area. This area would be circular in shape in the case of a non-rotating planet, or in the case of comparatively shallow vaporous envelopes like those which surround our earth. But in the case of masses of vapour flung upwards from the real surface of a rapidly rotating planet like Jupiter, with sufficient energy to burst their way through cloud layers thousands of miles above that surface, there would undoubtedly be a marked trailing off of the vaporous masses westwards. They would acquire a westerly motion sufficing to give the region of disturbance measurable superiority of length in an east-and-west direction. For the westerly motion would continue after the upflung vapours had reached their greatest height.

As a result of this process of westerly lagging the western end of the spot might be expected to be not quite so symmetrical in form as the easterly, a peculiarity which was actually noticed. Moreover, as the whole spot, or rather the whole of the cloud-region containing the spot would drift steadily westwards, the planet turning all the time rapidly eastwards (one rotation in less than ten hours) it follows that the spot would have a slightly longer rotation period than the equatorial markings,—which also was actually observed.

According to this interpretation, the great red spot on Jupiter would indicate the occurrence of a tremendous outburst at the planet's real surface, an outburst compared with which the great earthquake at Krakatoa was as child's play compared with the labours of many giants. That the outburst at its commencement was sudden may be well believed. Yet judging from the long continuance of the great spot and of the sequent disturbance, the eruptive action must have lasted a long time. Of course it does not necessarily follow that the disturbance which caused the great opening in the cloud envelope lasted as long as the opening itself. It may well be that the movements by which a disturbed cloud-belt on Jupiter returns to its normal condition, are sluggish compared with the fierce action by which the disturbance is brought about, at (or it may be below) the fiery surface of the planet itself. Still the gigantic elliptic ring seen as early as 1871, followed by a gigantic elliptic opening which remained for six years, and that again by a disturbed condition which has already lasted nearly three years and may last much longer,—all this seems quite inconsistent with the idea that the eruptive action giving birth (if my interpretation is correct) to this long-lasting disturbance was itself of short duration.

And after all, it would not be very surprising, when we consider the enormous scale on which Jupiter is constructed, the tremendous heat which must in all probability pervade his whole frame, and the correspondingly increased duration of all internal disturbances, if the analogues on Jupiter of volcanic outbursts which on the earth (so much smaller and now relatively aged) last often for many weeks, should on Jupiter last, occasionally, for several years. Jupiter, according to all reasonable probability, must be a very young planet. If his planetary career began at the same time as the earth's, he is certainly much younger than our earth; but even if he began his career as a planet millions of years before the earth, even then he would be younger than the earth in development. For those millions of years would be as nothing compared with the vast excess of the duration of Jupiter's life-stages over the duration of the corresponding life-stages of the earth. Regarding Jupiter as in a much more youthful stage of planetary life than the earth is now passing through, and remembering that even when Jupiter has reached the same stage as our earth his eruptive energies will be much greater than the earth's now are, we may well believe that the explosions now taking place on Jupiter must be on an incomparably grander scale than the mightiest volcanic disturbances on the earth. Applying to Jupiter the reasoning which was applied to the disturbance of Krakatoa in 1883, we might readily find that even a greater disturbance than the Great Red Spot indicated, tremendous and far-reaching though that disturbance was, could be explained, as resulting from a Jovian volcanic outburst, vaster and fiercer than terrestrial outbursts because Jupiter is at once a mightier and a much younger planet.

SCOTLAND AND SCANDINAVIA.*

By Professor Judd.

HE who enters on the study of Highland geology without being prepared to encounter at every step complicated foldings, vast dislocations, and stupendous inversions of the strata can scarcely fail to be betrayed into disastrous errors.

The early history of Scotland is inextricably interwoven with that of Scandinavia. This proposition, true as it is of the insignificant periods of which human history takes cognizance, applies with even greater force to the vast epochs that fall within the ken of the geologist. To us the separation of Scotland and Scandinavia is an event of very recent date indeed; it was not only an accident, but an uncompleted accident. The Scottish Islands, with the Hebrides and Donegal on the one hand, with Orkney and Shetland on the other, must be regarded, to use a technical phrase, as mere "outliers" of the Scandinavian peninsula. The great Scandinavian *massif*, with its outlying fragments, constitutes the "basal-wreck," to employ Darwin's expressive term, of a great Alpine chain.

On other occasions I have endeavoured to show how much our study of the nature and products of volcanic action was facilitated by the existence of similar "basal-wrecks" of volcanic mountains, like those which existed in their beautiful western isles. In the same way, I believe we may learn more, by the study of this dissected mountain chain, concerning the operations by which these grand features of our globe have originated, than by the most prolonged examination of the superficial characters of the Alps or the Himalayas. Here the scalpel of denudation has laid bare the innermost recesses of the mountain masses, and what we can only guess at in the Alps and the Himalayas stand in our own Highlands clearly revealed to view.

In offering a few remarks on some of the still unsolved problems of Highland geology, I shall not hesitate to

* From Professor Judd's opening address before the Geological Section of the British Association.

treat, as belonging to the same geological district, both Scandinavia and Scotland. Not only is the succession of geological deposits in the two areas almost completely identical, but the characters of the several formations and their relations to one another in the one country are almost the exact counterpart of what they are in the other.

At the base, and forming the foundation of this greatly-denuded mountain-chain, there exist enormous masses of highly-foliated, crystalline rocks. These, in great part at least, underlie the oldest-known fossiliferous strata, and are, therefore, of pre-Cambrian or Archæan age. In spite of the labours of Kjerulf, Dahl, Brögger, Reusch, Torneböhm, and many others in Scandinavia, and of Macculloch, Nicol, and their successors in this country, much still remains to be done in studying the petrographical characters and the geognostic relations of these wide-spread formations.

Although the bold generalisation which sought to sweep all the crystalline rocks of our central Highlands into the great Silurian net have admittedly broken down, yet it by no means follows that the whole of these rock-masses are of Archæan age. Nicol always held that among the complicated foldings of the Highland rocks many portions of the older Palæozoic formations, in a highly-altered condition, were included. The same view has been persistently maintained by Dr. Hicks, to whose researches among the more ancient rock-masses of the British Isles geologists are so greatly indebted, and also by Professor Lapworth. To the settlement of this very important question we may feel sure the effort of the officers of the Geological Survey will be especially directed.

The geological surveyors of Scandinavia have been so fortunate as to detect, in rocks of an extremely altered character, a number of fossils sufficiently well preserved for generic, and sometimes even for specific, identification. Failing the occurrence of such a fortunate accident, I confess that it has always appeared to me that the disturbances to which these Highland rocks have been subjected are so extreme, and the difficulty of making out the original planes of bedding so great, that but little can be hoped for from general sections constructed to show the relations of the rocks of the Central and Southern Grampians to the fossiliferous deposits of the north-west of Sutherland.

Since the last meeting of the British Association in the Highlands, much progress has been made in the study of that pre-eminently British formation—the old red sandstone. Dr. Archibald Geikie has thrown much new light, by his valuable researches, on the relations of the several members of the vast series of deposits which go by that name; while Dr. Traquair, bringing to bear on the subject great anatomical knowledge, has re-examined the collections of fossil fish made by that indefatigable explorer, Hugh Miller. The old red sandstone is the only system of strata which we possess, while it is either wholly absent or very imperfectly represented in Scandinavia.

In the year 1876 I was able to announce that a vestige—a small but highly interesting vestige—of the great carboniferous system existed within the limits of the Scottish Highlands. Overwhelmed by successive lava-streams that were piled upon one another to the depth of many hundreds of feet, and then carried down by a fault which buried it at least 2,000 ft. in the bowels of the earth, this fragment has remained while every other trace of the formation has been swept from the Highlands by the besom of denudation.

Down to post-glacial times Scotland and what were now its outlying islands remained united with Scandinavia. I need not remind you how during the glacial period they were the scene of a similar succession of events, while from their then far more elevated mountain-summits streams of glacier ice flowed down and relieved the mantle of snow which enveloped them. But at a very recent geological period—and indeed since the appearance of man in this part of our globe—the separation of the two areas, so long united, was brought about.

In the district now constituting the North Sea, which separates the two countries, great faults, originating in the Tertiary epoch, appear to have let down wide tracts of the softer Secondary strata among the harder crystalline rock masses. The numerous changes of level, of which we find such abundant evidence around the shores of this sea, facilitated the wearing away of the whole of these softer secondary deposits, except the slight fringes that remained along the shores of Sutherland, Ross, and Cromarty, on the one hand, and the isolated patches forming Scania, Jutland, and the surrounding islands on the other. Little could the Vikings, as they sailed over this shallow sea, have imagined that their predecessors in these regions were able to roam on foot from Norroway to Suderey.

It is almost impossible to over-estimate the effects produced by the several denudations to which Scandinavia and the Scottish Highlands have been successively subjected. In that which occurred during the later Tertiary periods, almost every portion of the non-crystalline rocks that rose above the sea level was either entirely removed or converted into level plains, which, covered with drift deposits, now form districts like Scania and Denmark. Whereas in the great central valley of Scotland hard volcanic masses are associated with the softer sedimentary rocks, the former are left rising as picturesque crags, standing boldly up above the general level, while the latter are worn down and buried under drift. In the west of Scotland a chain of volcanic mountains, with summits towering to the height of from ten to fifteen thousand feet, have been reduced by this same denudation to basal wrecks, the highest portions of which attain to but little more than 3,000 ft. above the sea level.

During the great elevation and denudation which marked the Neocomian period thousands of feet of strata must have been removed over wide areas, as is proved by the wonderful overlap of the cretaceous beds on all the old strata. Of the enormous sub-aërial waste which went on in these Northern Alps during the newer Palæozoic periods we have impressive evidence in the vast masses of the old red sandstone and carboniferous rocks—themselves only a series of fragments that had survived the later denudations—for these rocks were built up of the materials derived from our Northern Alps. The Torridon sandstone is the monument—and a very striking monument too—of another and still earlier period of enormous denudation. The thousands of feet of conglomerate and sandstone of which it is made up consist of the disintegrated crystals of granites and gneisses that have been swept away.

When we penetrate towards the axis of this eroded mountain chain the proofs of the magnitude of these denudations become even more strking and impressive. Here we see towering aloft the ruined buttresses of vast rocky arches that when complete must have risen miles above the present surface: there we find lying side by side rock masses that could only have been brought together by displacements of tens of thousands of feet; yet so complete has been the planing down of the surface

since, that it requires the most careful study even to detect the almost obliterated traces of these grand movements.

The Alps and the Himalayas during their elevation have suffered enormous waste and denudation; but if the elevation were to cease and the waste to go on till these magnificent mountain chains were reduced to masses of diminutive peaks, ranging from 2,000 ft. to 8,000 ft. in height, we should then have the counterpart of this stupendous ruin of the mountain chain of the north.

The history of the series of successive movements to which the rock masses of our Highlands has been subjected is one well worthy of the most attentive study. When the evidence bearing upon the subject is carefully sifted and weighed we become convinced of the fact that many of these movements—including some on a prodigious scale—must have taken place during what we are commonly accustomed to regard as comparatively recent geological periods. On the eastern coast of Sutherland a mass of secondary rocks, including several thousands of feet of triassic, rhætic, and jurassic strata, have been let down by a gigantic fault, so as to be placed in juxtaposition with the old red sandstone and the crystalline rocks. Now, taking the very lowest estimates of the thicknesses of the several strata affected, the vertical "throw" of this fault must have exceeded a mile. It may not improbably, indeed, have been at least double or treble that amount. Yet this great dislocation was certainly produced at a later date than the upper Jurassic period, for rocks of that age are found to be affected by it.

Along the coasts of the Black Isle strata of middle and upper Jurassic age are similarly found faulted against the "old red" and the crystalline rocks. On the other side of the North Sea, in Ando, one of the Lofoden Isles, a patch of lower oolite strata, consisting of marine and estuarine strata, and including beds of coal like that of Brora, is found let down by gigantic faults into the very heart of the crystalline rocks of the district. In Scania the whole of the secondary rock masses owe their preservation in the same way to a plexus of tremendous faults, by which they have been entangled among the harder rocks. Those faults have affected not only the Jurassic strata, but even the very youngest members of the cretaceous series.

Nor are we without evidence that some of the great faults are of post-cretaceous age in this country, for in the Western Highlands displacements of several thousands of feet have been detected which affect not only the upper cretaceous, but also the older Tertiary rocks.

The effects produced by these great dislocations, which had a generally parallel direction in our Highlands from north-east to south-west, are of the most startling character. Great strips of triassic and old red sandstone strata, like those of Elgin and Turriff and Tomintoul, and of the line of the Caledonian Canal, are found let down among the crystalline rocks by these gigantic faults. The great central valley of Scotland itself consists of masses of newer Palæozoic strata, faulted down between the harder Archæan and lower Palæozoic rocks, which form the Highlands on the one hand, and the border land on the other. That many of the stupendous earth movements which produced the foliation of the rocks of Scandinavia and the Scottish Highlands must be referred to Archæan times there is not the smallest room for doubt. That similar effects have resulted from the same agencies during subsequent periods our fellow geologists in Scandinavia believe they have found incontrovertible proof. For my own part, I look forward confidently to the establishment of the same conclusion from the study of our own Highland rocks.

THE YOUNG ELECTRICIAN.

By W. Slingo.

(*Continued from p.* 199.)

EX. CVIII. Fig. 61 illustrates a form of electroscope which may be very easily and cheaply made. The glass shade may consist of any ordinary bottomless unstoppered gas jar having a diameter of three or more inches, and a height of six inches or thereabouts. Jars of this kind are, comparatively speaking, dear, but the expenditure is not at all necessary, more especially if it is preferred to put one's self to a little trouble in order to save expense. The jar may be readily obtained by cutting down an ordinary clear glass bottle, such a one as spirits, &c., are often sold in. The cutting presents no serious difficulty if a little care is taken. Suppose A B, Fig. 62, to be the bottle. The neck usually bulges a little, as at C D. This is perhaps an advantage, for if the neck is a long one, we can cut it at C D, and the conical neck resulting will assist in fixing the stopper. Tie *as tightly as possible* pieces of fine twine round the neck at C D, and round the bottom of the bottle at E F. Then revolve the bottle in the flame of a spirit lamp so as to char in turn each piece of twine without setting fire to it. It will be found possible, after a few revolutions, to divide the glass by tolerable clear cuts under the twine, a gentle tap being applied now and then as the heating progresses.

A similar process, answering as well if not better, is to soak a piece of knitting-cotton or worsted in paraffin oil, tie it somewhat tightly to the bottle and then set fire to it. The bottle should be held horizontally, and protected from any considerable draught, so as to confine the flame as nearly as possible to the line of the cotton. After allowing the oil to burn nearly out, plunge the bottle in a basin of cold water as far as the cotton, when the neck or bottom, as the case may be, will fall off, leaving a tolerably clean cut.

These are plans which I have rarely found to fail, and have used them on several kinds of glass. Crosse & Blackwell's wide-mouthed pickle-bottles answer famously, and would be recommended for this purpose, were it not that the glass is somewhat too green. If the cut edges of the glass are exceptionally rough or uneven they may be filed down with a smooth or second-cut file, applying the tool gently. If a bastard (or coarse) file is used, or if too much pressure is applied, there is great danger of chipping off more than is desired. When tolerably even, the edges may be made as smooth as desired by grinding down on medium emery-cloth moistened with turpentine.

The jar being made, the next step is to fit the stopper (D Fig. 61). This may be an indiarubber cork (this is suggestive of an "iron milestone," by the way) or stopper. Such an article answers admirably, but it is expensive. Let us use either a good sound cork or, equally well if not better, a piece of dry wood—mahogany will do nicely. If there is any doubt about its dryness, place in a warm oven for a short time. Then cut it to shape and bore a hole through the centre (longitudinally) a quarter of an inch in diameter. Next immerse it in melted paraffin wax, until it is as thoroughly saturated as possible: this will prevent the subsequent entrance of moisture. Leaving this to soak, let us next cut off two

strips of tinfoil five inches long and an inch wide. Cover one face of each for four inches of its length with flour paste and therewith attach them to the inner surface of the jar, placing them four inches up the glass and as nearly as possible opposite each other or at the extremities of a single diameter, and leaving an inch of foil in each case free. Subsequently bend these free ends over the bottom edge and paste on the outside of the glass. Then procure a piece of copper, brass, or even iron wire, of any convenient thickness, pass it round the outside of the jar three-quarters of an inch from the bottom, twist the two ends tightly together (so as to prevent subsequent slipping), and bend the twisted ends in a hook as at C (Fig. 61). This hook affords a means of attachment for a light chain, wire or any other substance which may be used for an earth connection. The wire should make electrical contact with the tin-foil strips.

To return to the stopper. The hole is usually fitted with a piece of glass tubing, through which the metal wire W W is passed and held in position by binding it round with sufficient silk ribbon to make a tight fit ; but I scarcely think this is necessary, more particularly if the instrument is kept clean and free from dust. Let us simply use a piece of wire or rod six inches long, and fitting friction-tight into the hole in the wood. This is thicker than is really

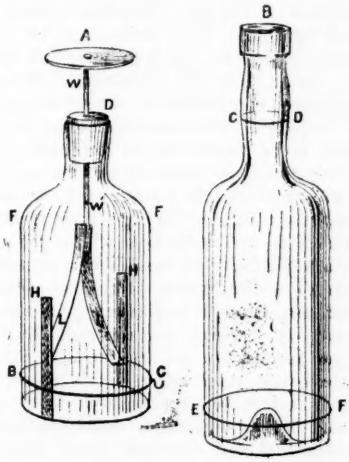


Fig. 61.

Fig. 62.

Fig. 63.

necessary, a much thinner piece of wire answering in most cases equally well; but the cost would not be more than a penny, and it would allow us to place a moderately heavy body on the plate A without any fear of the whole thing collapsing. After seeing to the fit remove it from the wood, and with a second-cut file work a small length (an eighth of an inch) down to about half the original diameter—that is, to an eighth of an inch. This may be done by securing the rod in a small hand-vice (Ex. XXVIII) which is placed in the left hand. Then, laying the end of the rod on the table, pass the file (held in the right hand) over it, turning it at the same time towards the file. At the same time an even shoulder C D, Fig. 63, should be formed. Next hammer down the end A to about the shape shown, making the extreme edge not less than half-an-inch wide. If the rod is of iron it will require to be made red-hot before it is hammered down.

The plate A, Fig. 61, may be cut from tinned iron, but, of course, brass looks nicer, is more substantial, and will fit better on to the rod. Cut a piece of metal (say a thirty-second of an inch thick) as nearly circular as possible, making the diameter 3 or 3½ in. Use a smooth file for finishing-off, and avoid leaving any points or other projections. Drill through the centre (Ex. XXIX. to XXXV.) a hole an eighth of an inch in diameter. Through this, pass the reduced end B of the rod A B, Fig. 63, and rivet together by hammering out the projecting portion B. See that A rests fairly on the shoulder C D, so as to avoid any danger of the plate tilting over at any time. If it is necessary—that is, if sufficient rigidity is not obtained, the two may be soldered together. (Ex. XI. to XIV.) Before fitting the plate, the rod must be passed through the wooden stopper again.

The next thing is to attach the leaves L L. These may be of Dutch metal, of which a whole book may be purchased for a few pence. Place a leaf (lifting it with the point of a clean knife-blade) between two pieces of note-paper, lay on a board, and cut two strips 3 in. or so long and ½ in. wide. Remove carefully the upper strips of paper, and, having already gummed the two flat faces on A (Fig. 63), lay one on the end of one of the metal strips, raise cleanly and carefully, and place the other face on one end of the other metal strip. If properly done the two leaves or strips will hang evenly and parallel. Above all, draughts should be avoided, and the fingers should be kept from coming into contact with the leaves. If any accident happens it is useless attempting to put matters right. The only resource is to cut another strip, or two if need be.

When the strips are in position, hold the rod vertically, pass the lower portion together with the strips into the jar, and fix the stopper, D, into the neck. Let W W (that is A B, Fig. 63), remain about 3 inches above the stopper. Then having prepared some sealing-wax or shellac varnish, brush a little over the stopper, sealing up any space that may be left in the central hole through which the rod passes, or any interstices that may present themselves between the stopper and the glass. A little ordinary sealing-wax may be used in the ordinary way with perhaps equal advantage, but it does not always look so neat as might be desired.

The young electrician will now be provided with a very efficient instrument, and I think it may fairly be said that the cost of the parts does not exceeded threepence, especially if only an iron rod and a tinned iron plate are used. Sometimes I have been driven into a hole for want of an electroscope. I have then extemporised one for the occasion with very satisfactory results ; but of this a few words next time.

SCRAPS FROM THE BRITISH ASSOCIATION.

THOUGH the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalised in all similar cases. Isolated facts may be viewed as the dust of science. The dust which floats in the atmosphere is to the common observer mere incoherent matter in a wrong place, while to the man of science it is all important when the rays of heat and light act upon its floating particles. It is by them that clouds and rains are influenced; it is by their selective influence on the solar waves that the blue of the heavens and the beauteous colours of the sky glorify all nature. So, also, ascertained through isolated facts, forming the

dust of science, become the reflecting media of the light of knowledge, and cause all nature to assume a new aspect. It is with the light of knowledge that we are enabled to question nature through direct experiment. The hypothesis or theory which induces us to put the experimental question may be right or wrong; still, *prudens quæstio dimidium scientiæ est*—it is half way to knowledge when you know what you have to inquire. Davy described hypothesis as the mere scaffolding of science, useful to build up true knowledge, but capable of being put up or taken down at pleasure. Undoubtedly a theory is only temporary, and the reason is, as Bacon has said, that the man of science "loveth truth more than his theory." The changing theories which the world despises are the leaves of the tree of science, drawing nutriment to the parent stems, and enabling it to put forth new branches and to produce fruit; and though the leaves fall and decay, the very products of decay nourish the roots of the tree, and reappear in the new leaves or theories which succeed—*Sir L. Playfair.*

The coal which has hitherto been the chief source of power probably represents the product of five or six million years during which the sun shone upon the plants of the carboniferous period, and stored up its energy in this convenient form. But we are using this conserved force wastefully and prodigally; for, although horse-power in steam engines has so largely increased since 1864, two men only now produce what three men did at that date. It is only 300 years since we became a manufacturing country. According to Professor Dewar, in less than 200 years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem—What will be the condition of England without coal? The answer to that question depends upon the intellectual development of the nation at that time. The value of the intellectual factor of production is continually increasing; while the values of raw material and fuel are lessening factors.—*Sir L. Playfair.*

Few would ask now, as was constantly done a few years ago, "What is the use of an abstract discovery in science?" Faraday once answered this question by another, "What is the use of a baby?" Yet round that baby centre all the hopes and sentiments of his parents, and even the interests of the State, which interferes in its upbringing so as to ensure it being a capable citizen. *Sir L. Playfair.*

Let me take a single example of how even a petty manufacture improved by the teachings of science affects the comforts and enlarges the resources of mankind. When I was a boy, the only way of obtaining a light was by the tinder-box, with its quadruple materials, flint and steel, burnt rags or tinder, and a sulphur match. If everything went well, if the box could be found and the air was dry, a light could be obtained in two minutes; but very often the time occupied was much longer, and the process became a great trial to the serenity of temper. The consequence of this was that a fire or a burning lamp was kept alight through the day. Old Gerard, in his herbal, tells us how certain fungi were used to carry fire from one part of the country to the other. The tinder-box long held its position as a great discovery in the arts. The *pyxidicula igniaria* of the Romans appears to have been much the same implement, though a little ruder than the flint and steel which Philip the Good put into the collar of the Golden Fleece in 1429, as the representation of high knowledge in the progress of the arts. It continued to prevail till 1833, when phosphorus matches were introduced, though I have been amused to find that there are a few venerable ancients in London who still stick to the tinder-box, and for whom a few shops keep a small supply. Phosphorus was no new discovery, for it had been obtained by an Arabian called Bechel in the eighth century. However, it was forgotten, and was rediscovered by Brandt, who made it out of very stinking materials in 1669. Other discoveries had, however, to be made before it could be used for lucifer-matches. The science of combustion was only developed on the discovery of oxygen a century later. Time had to elapse before chemical analysis showed the kind of bodies which could be added to phosphorus so as to make it ignite readily. So it was not till 1833 that matches became a partial success. Intolerably bad they then were, dangerously inflammable, horribly poisonous to the makers, and injurious to the lungs of the consumers. It required another discovery by Schrötter in 1845 to change poisonous waxy into innocuous red-brick phosphorus in order that these defects might be remedied, and to give us the safety-match of the present day.—*Sir L. Playfair.*

The true cultivators of the tree of science must seek their own reward by seeing it flourish, and let others devote their attention to the possible practical advantages which may result from their labours. There is, however, one intimate connection between science and industry which I hope will be more intimate as scientific education becomes more prevalent in our schools and universities. Abstract science depends on the support of men of leisure, either themselves possessing, or having provided for them, the means of living without entering into the pursuits of active industry. The pursuit of science requires a superfluity of wealth in a community beyond the needs of ordinary life. Such superfluity is also necessary for art, though a picture or a statue is a saleable commodity, while an abstract discovery in science has no immediate or, as regards the discoverer, proximate commercial value. In Greece, when philosophical and scientific speculation was at its highest point, and when education was conducted in its own vernacular and not through dead languages, science, industry, and commerce were actively prosperous. Corinth carried on the manufactures of Birmingham and Sheffield, while Athens combined those of Leeds, Staffordshire, and London, for it had woollen manufactures, potteries, gold and silver work, as well as shipbuilding. Their philosophers were the sons of burghers, and sometimes carried on the trades of their fathers. Thales was a travelling oil merchant, who brought back science as well as oil from Egypt. Solon and his great descendant Plato, as well as Zeno, were men of commerce. Socrates was a stonemason; Thucydides a gold-miner; Aristotle kept a druggist's shop until Alexander endowed him with the wealth of Asia. All but Socrates had a superfluity of wealth, and he was supported by that of others.—*Sir L. Playfair.*

Science has in the last hundred years altered altogether the old conditions of industrial competition. She has taught the rigid metals to convey and record our thoughts even to the most distant lands, and, within less limits, to reproduce our speech. This marvellous application of electricity has diminished the cares and responsibilities

of Governments, while it has at the same time altered the whole practice of commerce. To England steam and electricity have been of incalculable advantage. The ocean, which once made the country insular and isolated, is now the very life-blood of England and of the greater England beyond the seas. As in the human body the blood bathes all its parts, and through its travelling corpuscles carries force to all its members, so, in the body politic of England and its pelagic extensions, steam has become the circulatory and electricity the nervous system. The colonies, being young countries, value their raw materials as their chief sources of wealth. When they become older they will discover it is not in these, but in the culture of scientific intellect, that their future prosperity depends. Older nations recognise this as the law of progress more than we do; or, as Jules Simon tersely puts it, "That nation which most educates her people will become the greatest nation; if not to-day, certainly to-morrow."—*Sir L. Playfair.*

No great discovery flashes upon the world at once, and, therefore, Pope's lines on Newton are only a poetic fancy—

> "Nature and Nature's laws lay hid in night,
> God said, 'Let Newton be,' and all was light."

No doubt the road upon which he travelled had been long in preparation by other men. The exact observations of Tycho Brahe, coupled with the discoveries of Copernicus, Kepler, and Galileo, had already broken down the authority of Aristotle and weakened that of the Church. But, though the conceptions of the universe were thus broadened, mankind had not yet rid themselves of the idea that the powers of the universe were still regulated by spirits or special providences. Even Kepler moved the planets by spirits, and it took some time to knock these celestial steersmen on the head. Descartes, who really did so much by his writings to force the conclusion that the planetary movements should be dealt with as an ordinary problem in mechanics, looked upon the universe as a machine, the wheels of which were kept in motion by the unceasing exercise of a divine power. Yet such theories were only an attempt to regulate the universe by celestial intelligences like our own, and by standards within our reach. It required the discovery of an all-pervading law, universal throughout all space, to enlarge the thoughts of men, and one which, while it widened the conceptions of the universe, reduced the earth and solar system to true dimensions. It is by the investigation of the finite on all sides that we obtain a higher conception of the infinite—

> "Willst du ins Unendliche schreiten,
> Geh nur im Endlichen nach allen Seiten."
>
> —*Sir L. Playfair.*

Navigation and commerce mightily benefited by our better knowledge of the motions of the heavenly bodies. Still, these benefits to humanity are incomparably less in the history of progress than the expansion of the human intellect which followed the withdrawal of the cramps that confined it. Truth was now able to discard authority, and marched forward without hindrance. Before this point was reached Bruno had been burned, Galileo had abjured, and both Copernicus and Descartes had kept back their writings for fear of offending the Church. The recent acceptance of evolution in biology has had a like effect in producing a far profounder intellectual change in human thought than any mere impulse of industrial development. Already its application to sociology and education is recognised, but that is of less import to human progress than the broadening of our views of Nature. Abstract discovery in science is, then, the true foundation upon which the superstructure of modern civilisation is built; and the man who would take part in it should study science, and, if he can, advance it for its own sake and not for its applications. Ignorance may walk in the path lighted by advancing knowledge, but she is unable to follow when science passes her, for, like the foolish virgin, she has no oil in her lamp. An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle for existence. The sum of such truths forms the intellectual treasure which descends to each generation in hereditary succession. Though the discoverer of a new truth is a benefactor to humanity, he can give little to futurity in comparison with the wealth of knowledge which he inherited from the past. We, in our generation, should appreciate and use our great possessions—

> "For me your tributary stores combine,
> Creation's heir; the world, the world is mine."
>
> —*Sir L. Playfair.*

Mr. Buchan, secretary of the Meteorological Society of Scotland, read a paper on the rainfall of the British Islands, in which he gave the results of observations during the twenty-four years from 1860 to 1883, at 1,080 stations in England and Wales, 547 in Scotland, and 213 in Ireland; in all 1,840. The regions of heaviest rainfall marked off by an average of 80 in. or upwards annually were four—Skye and a large portion of the mainland to the south-east as far as Luss, on Loch Lomond, the greater part of the Lake district, a long strip including the more mountainous part of North Wales and the mountainous district in the south-east of Wales. The West Highlands presented the most extensive region of heaviest rainfall in the British Islands. The heaviest rainfall in Scotland, 128·50 in., was at Glencroe. On the other hand, the smallest rainfall, varying from 22·50 in. to 25 in., overspread a large section of the south-east of England from the Humber to the estuary of the Thames, excluding the higher grounds of Lincoln and Norfolk, and including a small patch in the valley of the Thames from Kew to Marlow.

Mr. J. Wilson Swan read a paper on an electric safety-lamp for miners, in which he submitted the latest result of an attempt to adapt electric lighting to the requirements of coal-mining. He said it was more than doubtful if any of the lamps at present in use were safe in an explosive atmosphere in a state of abnormally rapid motion, or when subject to a rush of air, such as a blast or the accidental swing of a lamp might occasion. The fragile partition of wire gauze, which alone presented a barrier to the passage of flame from the lighted wick inside the lamp to an explosive mixture of gas outside, was too slight a defence against the danger of explosion. The lamp which he submitted for examination was protected by a very thick glass bull's eye, light being economised by a silvered reflector behind the lamp. Two sockets within the case provided the means of connecting the battery terminals with the charging circuit. The combined apparatus of battery and lamp weighed 6¾ lb., and the cylindrical case containing the cells measured 8 in. by 4 in. Mr. Swan claimed for the new lamp that it possessed the merit of being absolutely safe. If it was neither so light nor so cheap as the ordinary lamp, it was in both respects at least practicable, and especially was it to be noted that the working cost would probably not be more than that of the ordinary lamps. As regarded the

weight, he was not without hope of being able to reduce it. The lamp did not, like others now in use, indicate the presence of fire-damp.

Mr. James N. Shoolbred gave some facts bearing upon the electric lighting of the Forth-bridge works. The electrical plant employed in the lighting of the works consisted, he stated, of thirteen dynamo machines, 100 large arc lamps of 2,000 candles each, 500 incandescent lamps of 200 candles, and about twelve miles of mains. Among the many interesting operations which had occurred was the lighting of the deep-water caissons for the main piers, in some cases from 70 ft. to 80 ft. under water. Those at South Queensferry were lit by incandescent lights, while at Inchgarvie, owing to blasting operations being necessary, arc lamps were employed. The firing of the blasting charges was also performed from the same dynamo which was providing the lighting.

Gossip.

By Richard A. Proctor.

From all sides we receive promise of good support for Knowledge in the monthly form. The weekly Knowledge will continue till October 16th, on which day the last number of the old series will appear. The first number of the new series will bear date November 1st, and be called the November number of Knowledge, *a Monthly Illustrated Magazine of Science, Literature, and Art*. Science will as heretofore be our chief subject; but we wish to be free to introduce Literary and Artistic matter when occasion may arise, without seeming, as at present, to act inconsistently with our announced purpose.

During the next four weeks our plans in detail for the new series will be fully indicated.

A letter by "Kolokol," in this week's issue, touches on a question of some interest. It does seem a pity that musical power should be so often wasted for want of fingering skill, or some other matter of *technique*. Of two musicians one shall have the true musical faculty, the power of bringing out the real thought and meaning of a great composer, but so little manual dexterity—for want of time and opportunity for practice, that he shall be unable to produce music worth listening to, when he attempts anything at all difficult; the other shall possess marvellous skill in execution, the result of thousands of hours of practice, yet wanting the soul of music his performance shall be far better worth watching than worth being listened to. The number of those who play skilfully is great, the number of those who if they had manual skill could play movingly, is considerable. But those who combine both qualities—and both are absolutely needed, as musical instruments are at present constructed—are few and far between. To one who like myself may not have an hour per month for musical practice, the trouble touched on by "Kolokol" is trying. I am not thinking of music as preposterously employed for display. The "little bit of music" asked for at social gatherings is generally a great nuisance with little music in it indeed. But to those whose work engrosses their attention closely while they are engaged on it, music—if they love music—would be a great aid were not the necessary skill so difficult to acquire and retain. I would certainly be willing to pay a long price if I could have, without incessant practice, the power of rendering such music as I love, in such a way as would correspond with my own idea of its meaning. I do not want to hear some one else play, still less to have an automatic rendering of the piece I love; nor do I want to play it for others to hear; I simply long to dwell on its melody, to enjoy its harmonies, to feel the emotions to which it appeals. And I want to do this at some moment of weariness or anxiety,—not to put off the matter to such and such an evening when,—in evening suit, in a gassy atmosphere, and in the glare of too much light,—I may hear Von Bulow, or Rubinstein, or some other performer, render that music to the accompaniment perhaps of chattering fan-flipping idiots who go to musical entertainments because it is the fashion, and have taken, unfortunately, some neighbouring seats.

But however one may love music or in particular some special movement, one may be utterly unable to render it. A few lines, and some awkward passage comes,—one stumbles—and ere many miuutes are over all power of enjoying the piece passes away.

We do not get from music one-hundredth part of what music might do, even as it is,—even with instruments requiring more practice than most men can afford to give. We use music, indeed, oftener for torture and annoyance than for pleasure. Nine out of ten of those whose music we have to hear have learned how to play with considerable dexterity—or ambidexterity—but have no more idea of rendering the conceptions of the great composers than they have of angelic flying.

Speaking of angels, I want to know why I was seized the other day with a fit of shouting-laughter, at the sight of a very lovely angel, with the conventionally graceful though impossible wings, the usual evidence of excellent diet, the customary Greekish costume, and differing only from other angels in *wearing boots*. They were very nice boots, fur-lined and slightly Balmoralish in shape (I could not see if they were fashionably high-heeled): but why should I be compelled to laugh consumedly at an angel in boots, more than at Guido's angels with violins and triangles? There are many angels in braces,—at Pugin's Catholic Church in Clapham the angels have really excellent braces,—and braces seem as funny for an angel as boots, if not funnier. Yet I have refrained even from smiling at the braced angels, while the Balmorally-booted angel overcame me at once. I find nothing in Herbert Spencer's "Philosophy of Laughter" to explain this.

I do not know how angels' boots are fitted. Most of the wingless angels on earth have boots not fitted at all—and one would gladly hear that schools of art were teaching these angels the proper shape of feet, and the superiority of walking over tottering. But Mr. W. M. Williams has certainly described the only proper way to get shoemakers to fit one with comfortable boots. I am not so much adopting his idea as commending it, on the *experte-credo* principle. I wear always a thin sock over a thick one, or even two thin ones, when I go to be measured for boots. For the average shoemaker seems to think himself bound to pinch you, and then to repeat that standing lie, "They will soon wear easy, Sir." Most assuredly that is a proposition of which one may say *Solvitur ambulando*: it is resolved into the falsehood it is, when you try walking. (This is an entirely new rendering.)

MISS BALLIN, in commenting on the mistake I made in substituting the sun for the earth, when dealing with the question of the ruddy solar eclipse, tells of a remarkable case in which Trousseau, after carefully weighing the question whether he would or would not give a patient belladonna, as usual, for a particular ailment, and determining that he would *not*, nevertheless wrote out the usual prescription and gave it to the patient in perfect unconsciousness that he was not carrying out his purpose.

ONE of the oddest cases of the kind which has ever occurred to me in literary work happened when I was correcting one of the earliest sheets of my first book—"Saturn and its System." I was describing Kepler's discovery of his third law, as illustrated by the periods and distances of Saturn and the Earth. After representing the distance and period of the earth, both, by unity, and so getting two numbers, one representing the distance the other the period of Saturn, I went on to consider the power of these numbers as follows,—"The first is less than the second, but the square of the first is greater than the second; let us then try the square of the second;—the square of the first is less than the square of the second, but the next or third power of the first is equal to the square of the second: here then is the law we are seeking" or words to that effect. All this was correctly printed. Reading a review of the book in the *Quarterly Journal of Science*, I found the author of the review asking what I could possibly mean by saying of the above-named numbers "The first is less than the second; but the square of the first is greater than the square of the second,"—which is obviously unmitigated nonsense (or as a friend described an article of mine the other day, "unparalleled rot"). I turned to the passage, and there was the preposterous statement. Now in those days, being but a beginner, I had kept the proofs and revises of my book with exemplary care. I turned therefore to these. And I found this startling thing:—I had deliberately corrected the first proof, in which the matter had been quite correctly stated, into the absurdity criticised. If I had originally written that nonsense, and passed it in proof and revise, I should not have wondered,—or at any rate I should not now wonder, knowing what can be done in that way. But to take the correct statement and deliberately alter it into nonsense, was surely a strange thing for the abstracted mind to do.

IN my "Transits of Venus" I wrote, and corrected in proofs and double revises, "seconds" for "minutes," throughout ten or twelve pages, in regard to the most important time-elements in the whole problem of determining the sun's distance from transit observations,—viz., the difference of duration of the transit for the Halleyan method, and the difference in the times of beginning and ending for the Delislean.

PROFESSOR KAISER of Leyden dealing with the rotation-period of Mars with exceptional care, and considering every detail, even to some not capable of affecting the result by the one thousandth of a second, made two gross mistakes, affecting the result by a full tenth of a second. I have myself, frequently, while differentiating and integrating like harlequin, without a slip, made mistake in multiplication and division that a child would be ashamed of. I was once two hours bringing two calculations into agreement, through a mistake in dividing by *two*.

"Let knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

The Editor is not responsible for the opinions of correspondents.

All Remittances, Cheques, and Post-Office Orders should be made payable to MESSRS. WYMAN & SONS.

NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

PRACTICAL WORK FOR SCIENCE—STAMMERING—INSTRUMENTAL MUSIC.

[1925]—You open your columns to all comers who have anything to say bearing on practical matters. Permit me a word. First, as regards stammering. There are advertisements to be met frequently from persons who undertake to cure stammering. But let any one go to these and say, "I wished to be cured, name your price, to be paid on completion of cure. I will deposit the money with some trustworthy person. I am most anxious to be cured, and will follow minutely all your directions," what will the answer be? Hemming and hawing, and shuffling. Stammering is greatly on the increase. Why will not scientific men take the matter in hand? Any man who could *really* cure this disease would be able to retire in a few years with a large fortune. I know several men, to whom money is no object, who would give large sums to be cured of stammering; but, then, it must be a cure. Second, as regards instrumental music, many men, having had neither time nor opportunity in their youth to study music, are anxious, as leisure comes to them, to shine later in life—say from twenty-five to forty-five—to play some instrument. They begin to practise, but the hand does not answer the brain. The theory is easily acquired, but the joints and ligaments of the fingers, hand, and wrist are stiff and disobedient. Is it impossible to bring scientific aid to bear here? I have been told that eight hours' a day practice for ten years would produce the required result; what we want is an hour or an hour-and-a-half for a twelvemonth to enable us to join in a quartett or symphony party. Flexibility of finger and strength of muscle must be obtained; if this can be assisted by science, the rest is easy. I have taken KNOWLEDGE from the beginning, and have seven handsome volumes on my shelf of interesting and useful matter. I will miss greatly the weekly issue; but I hope the monthly one will be as successful as its predecessor. KOLOKOL.

THE OCULAR SPECTRA.

[1926]—It will be quite evident to anyone who is not preoccupied with his own notions, and who may have carefully read my letters on the Ocular Spectra—a class of phenomena I have so long and carefully observed, a class of phenomena on which, as I have shown, the ultimate science of chromatics must be founded—that my expression, "no external existence whatever" meant simply, that these spectra are not copies of images external to our own being, as is taught in most works on colour, but that they are merely phenomena of our inner consciousness, of which it is impossible to determine the precise seat. When touching upon the origin of these spectra in my several letters, I have attributed them to reactions in the optic sense caused by some strong primal excitation from without, so that there is not the slightest ground for imputing to me the denial of external causation. I do not deny externality to these causes, but to the optical effects of these causes—two very different things. No letter of mine was specially penned as a reply to any remarks made by Mr. Alexander; my purpose was to carry out a complete exposition of the phenomena from observation and knowledge. I merely touched *en passant* on his rather abrupt and unwarranted expression of surprise. W. CAVE THOMAS.

A SHOWER OF SNAILS.

[1927]—It may be interesting to some of your readers to know that, during a downpour of rain on Thursday, 3rd inst., a very thick shower of small snails fell with it, in Pembroke Dockyard. They

literally covered the ground in a space of about one hundred yards' diameter. They were all about the same size. Most of them were alive and creeping about for a couple of days after they fell.

B. REYNOLDS.

OCEAN TELEGRAPHY.

[1928]—In your last number, under "Gossip," you invite evidence on the trustworthiness of transatlantic telegraphy. I take pleasure in giving you the following facts:—

The firm I serve is almost daily in communication with New York, Charleston, S.C., and Memphis, Tenn. (probably a very good reason why our messages arrive so punctually and correctly). We pass messages in English, French, Latin, and Spanish severally. Our cables often consist of thirty to forty words, and are almost invariably correct transmissions, to a letter. Errors, of course, do occur, but, my impression is, through illegible writing on the sender's part more often than from carelessness on the part of the cable officials.

As a rule, our transatlantic friends dispatch their messages at the close of their business—6 to 7 o'clock, and the same are usually to hand on the following morning.

I think I see a moral in your conductor's experience. In future, despatch messages from the local head office only.

I take this opportunity of expressing my regret that KNOWLEDGE in future is to be a monthly publication, as I shall be a loser (intellectually); but I trust it will receive the success it deserves.

O. R.

THOUGHT TRANSMISSION.

[1929]—During the year 1872 or 3, when a law student in London, I saw in one of the V. C. Courts an elderly Q.C. who was partially paralysed, and who made mems. with his left hand. A Chancery clerk whispered his name to me, and remarked that he did a larger business in that Court than any other Q.C., and that he had "all the brains of the bar." I thought no more of him until Thursday morning last, when I woke about 7.30 and, to my surprise, found I was thinking about this particular barrister, whose name I could not recollect. I see in the *Standard* of to-day that a Mr. Southgate, Q.C., died on that day, and, if I am not mistaken, that was the name of the gentleman. If I am wrong, this letter is only good for the waste-paper basket, but if I am correct in thinking that Mr. S. was paralysed, and wrote with his left hand, I consider it quite as interesting a coincidence as that described in "R. T. C.'s" letter (1912) on "Thought Transmission," which I have just been reading, and I should much like to know at what hour Mr. S. died.

M.A., S.S.C.

MENTAL DEVELOPMENT.

[1930].—According to "Hallyards," in KNOWLEDGE, No. 1891, we Europeans are "but a compost" (we should have preferred some other term, for this word savours of the stable-yard), "of Italian, Celtic, and German savages of old," he does not tell us whence they came, "these savages of old," or whether they were like Topsy, who "guessed she grow'd."

If we look back into the history of the world, or, further still, to pre-historic times, we shall be able to trace the rise, growth, and decadence of various ornamental arts on our continent.

Many reasons might probably be advanced for the gradual decadence of art in Europe, and the deterioration in certain manuactures, but we will only touch upon one or two of the most prominent and likely ones.

It seems a very general rule, that as soon as any European nation attains a high degree of civilisation they become intensely progressive in their ideas, things begin to go at railway speed, articles are turned out to please the million, the declension of art is inevitable, the goldsmith's work, sculptures carpets, &c., are turned out to pattern or to order instead of being, like the paintings of Fra Angelico or the metal-work of Benvenuto Cellini, a creation of the artist soul, not executed for the praise of men, but because their art was a part of their life; such men were not the mere human machines which they necessarily become under the conditions of the nineteenth century, in which the increasing demand is for novelty, not quality. Many articles which in former times were only within reach of the few are now obtainable at a small cost in money; but how inferior in quality!

The tendency to imitation, and that not of the best kind, causes inferior materials to be used; the thing made may have some likeness to the original, but the same amount of labour and thought has not been bestowed upon it; one step has already been made in the downward career of the art or the manufacture. To give an instance of this:—Some years ago, when in India, we were shown some embroideries coming from Kashmir, suitable for trimming ladies' woollen dresses; the designs upon them had most likely been handed down for generations in that country with but few variations, where the tailors form one caste, the goldsmiths another. It was much desired to open out a market for these embroideries in England, where it was thought that they might sell at a remunerative rate, and thus secure a means of livelihood to the 20,000 durzies (tailors), who had been thrown out of employment in Kashmir by the cessation in the demand for the Kashmir shawls which ensued after the Franco-Prussian War of 1870. We admired the embroideries as they deserved, but at the same time remarked that they would not *take* in England with the general public, who are ever seeking novelty; but, let the patterns once be seen in our country, they would speedily be imitated, and appear in a "cheap and nasty form." Our friend looked incredulous, but this prophecy came true; a dress made by a European firm in India eighteen months later was trimmed with a *galon* which was evidently a reproduction (in loom and not hand-work) of one of these Kashmir designs.

In Asia, where conservative principles are retained in everything, in religion, in dress, arts, and manufactures, the people of a particular caste or district are unchanged from what they were a couple of thousand years ago—one particular family or tribe pursues the same calling from generation to generation, *e.g.*, a draughtsman continues to copy the designs which have come down to him from his ancestors; and, even more than this, a goldsmith who belongs to Central or Southern India will be found utterly incapable of making a bracelet similar to one which was bought either in Kashmir or in the Punjab, even if the original be given him to work from.

The people of the so-called Bronze Age in Scandinavia, whom we suppose "Hallyards" would class as Keltic savages, produced, nevertheless, goldsmiths who were most exquisite workers in the most precious of all metals. The Bronze Age in those northern lands is supposed from first to last to have had a duration of about a thousand years, and to have terminated about 100 A.D. Its art has been divided into two distinct periods—the earlier and the later Bronze Age. When we contemplate the objects which have been classed as belonging to the former of these, we at once see what a wide gulf separates it from the Stone Age which preceded it. Whence came this race? They were certainly not in a very low state of civilisation from the very first (the forms of and the designs on their goldsmith's work are witnesses of this fact); in innumerable ornaments made by them, the designs are the same as those we find now existing in Kashmir and in Hindostan proper: we must believe that they brought their cunning with them from Asia; for, not in their personal adornments only, but in the very material which they wore, fragments of which have been found in graves in Denmark which owe their preservation to the oaken coffins which contained them, and in their architecture also we can trace the resemblance to the Asiatic forms adopted by the dwellers in the high and mountainous regions of India, where wood was plentiful as in Scandinavia. A reason which we would urge for the decline of art in Greece is, that at the time when Christianity and Paganism were in a state of rampant antagonism to each other the former (represented by the Byzantine and Greek Churches) adopted a stereotyped form for the representations of the Saviour and the saints; and thus a great barrier arose between Greek religious and secular art as time progressed and Christianity gained a firmer hold on the minds of the people, the material worship of the finest type of human beauty languished, and then became extinct. A very curious thing happened to us when in Greece about six years ago, which gives us ground for the supposition that Greece also originally derived her knowledge of true art from Eastern lands. When visiting Megara, a village about fifty miles from Athens (the occasion being their annual fête), one of our party, then just returned from India, chanced to be wearing a dress trimmed with silver buttons bought at Benares, and other Indian ornaments. Many of the peasant women present seemed much attracted by them, and even went up to the wearer and touched them. A Greek gentleman standing by was requested to inquire why they gazed so intently at these ornaments and desired to examine them closely. Their reply may, we think, serve as an answer to Hallyards' question. It was, "Because they are so like our own!"

COSMOPOLITAN.

GRAIL AND WHITSUNDAY.

[1931]—The etymologies of "Grail" and "Whitsunday" have been determined on scientific principles. In Skeat's "Concise Etymological Dictionary" they are given as follows, as if expressly in answer to "Hallyards":—

"Grail, the holy dish at the Last Supper (F. L. Gk.). The etymology was very early falsified by an intentional change from *San Greal* (Holy diet) to *Sang Rael* (Royal blood, perversely taken to mean Real blood).—O. F. *graal, greal, grasal*, a flat dish; with numerous other forms both in O. F. and Low L. It would appear that the word was corrupted in various ways from Low L. *cratelta*, a small bowl, dimin. of *crater*, a bowl: see *Crater*."

"Whit-Sunday (E.) Literally *White-Sunday*, as is perfectly

certain from the A.S. name, *hwita sunnan-dæg;* Icel. *hvitasunnudagr;* Norwegian, *kvittsunndag*. These are facts, though constantly denied by the lovers of paradoxical and far-fetched etymologies. The difficulty lies only in the reason for the name. The great festivals, Yule, Easter, and Pentecost, but especially the two latter, were the great seasons for christening; in the Roman Catholic Church, especially Easter, whence in Roman usages the Sunday after Easter was called *Dominica in Albis;* but in the Northern churches, perhaps owing to the cold weather at Easter-time, Pentecost . . . . seems to have been especially appointed for christening and ordination; hence the following week was called the Holy Week, Icel. *Helga Vika* ('Icel. Dictionary'). The case is parallel to that of noon, which at first meant ninth hour, or 3 p.m., but was afterwards shifted. So also in other cases. Derivatives:—*Whitsun-week*, short for *Whitsunday's week* (Icel. *hvitasunneedags-vika*); *Whitsuntide*, short for *Whitsunday-tide*."

Abbreviations:—F., French; O.F., Old French; L., Latin; Gk., Greek; E., English; A.S., Anglo-Saxon: Icel., Icelandic; the sign - signifies derived from.

T. COMMON.

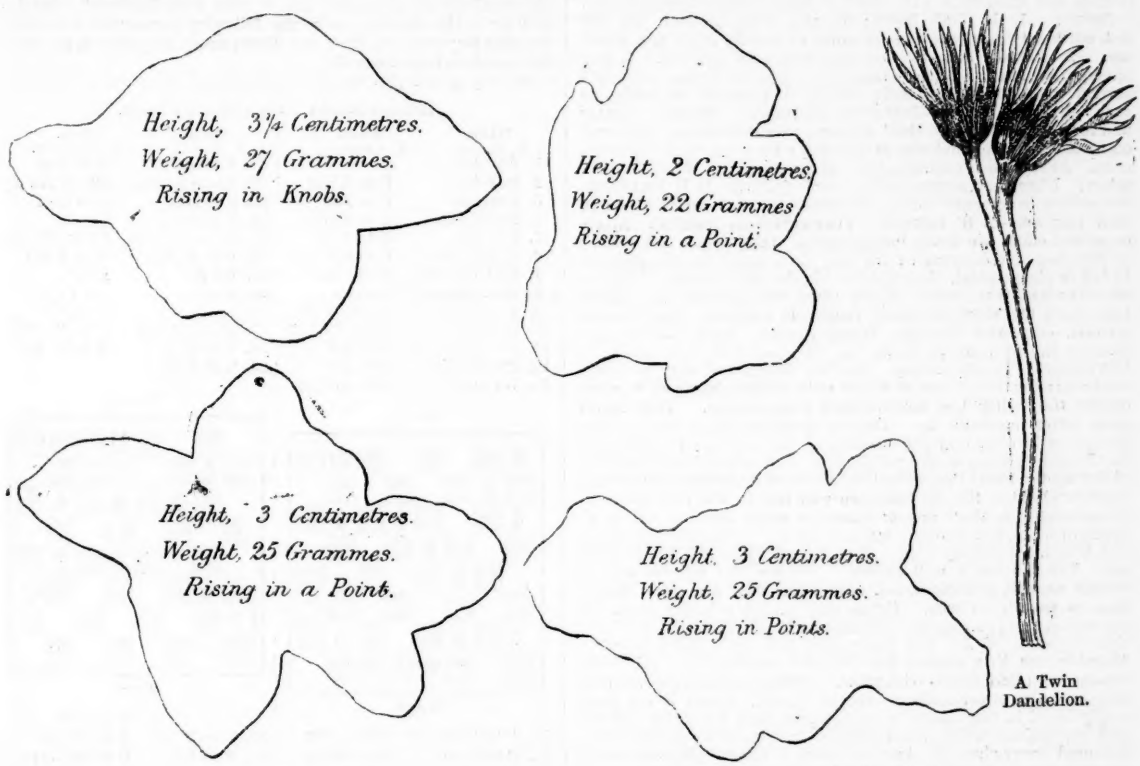
EASTward might keep the moon always due south." I should have considered this a printer's error, but he goes on to say that this traveller would have to travel round the earth in a day AND ABOUT fifty minutes.

Surely for a person to always keep the moon due south he must travel WESTward at the rate of the earth's revolution on her axis, LESS the distance travelled by the moon eastward, or about fifty minutes in the twenty-four hours.

I have been a reader of KNOWLEDGE for more than two years, during which time several small changes have taken place generally—in my opinion, for the better. I hope the approaching one will be in that direction.

W. H. S.

[Westward, certainly not eastward; but a day *and* fifty minutes is right and should have shown "W. H. S." that the error was a printer's one. If the man travels at the less rate correctly indicated by our correspondent, will he not take a longer—not a shorter—time in completing the circuit?—R. P.]



A Twin Dandelion.

FALL OF ICE.

[1932]—I send you tracings I made from lumps of ice that fell at this place, that I picked up ten minutes after the storm. The whole day a great deal of rain fell, at about 4 o'clock p.m. rumbling thunder, then a rushing wind, and these lumps of ice fell (part of an ice storm) with slashing rain. The storm lasted about three minutes. I took them down to the chemist and had them weighed and measured, therefore you can be sure of the correctness of what I state. When they actually fell they must have been bigger, for it was raining too heavily. I then had to dress and take them to the chemist's, which took another ten minutes. I wrapped them in a towel to keep them from melting. Saint Martin is about 978 mètres above the sea. I take this from the guide-book.

ISABELLA TERRELL.

Pension Américaine Anglaise, Saint Martin Lautosque,
Alpes Maritimes, France, Sept. 4, 1815.

KEEPING THE MOON DUE SOUTH—A PRINTER'S ERROR.

[1933]—I think Mr. Proctor must have made a mistake in his article on "Finding the Way at Sea," on page 177, KNOWLEDGE, where he says that a "traveller who could only go fast enough

A TWIN DANDELION.

[1934]—On the 7th inst. I found in a field near here a double dandelion. It has two distinct stalks, but they grow close together (one cuticle surrounding both) till within about an eighth of an inch from the top, where they separate, each bearing a flower. Have any of your readers ever come across such a phenomenon?

Sept. 8, 1885. IGNORAMUS.

LETTERS RECEIVED AND SHORT ANSWERS.

JAS. HEFFERMAN. With the new arrangements pending the subject of musical beats would not suit these pages.—A. J. S. A reply to any rude letter not seen by readers is necessarily suggestive of a tendency to quarrel, and may well appear somewhat egotistical. *That* is precisely why the replies are to be discontinued. Oddly enough the very writers who are rudest are the first to comment on the roughness of retorts. Now, if I were as rude (for example) to you, as you are to me—how would that be?—J. You are begging the question in saying that the Spencerian system advocated in my articles on the "Morality of Happiness" involves a lower standard. Even if the other system were followed it would not be higher; for it is less accordant with reason, and man is a reasoning animal. That standard is highest which promises the best results. You would say "shoot at the moon and your arrows though they may

not reach her will go over yonder hill." But this is moonshine if the moon is low. It requires much higher aims, more constant thought, and a more steadfast resolution to combine due regard for others with the necessary care of self than even to try to carry out the purely altruistic system. But if this may be said of the honest attempt to do that, what shall be said of the false and dishonest system by which millions talk of doing it, and never think of even trying to? That is no lofty ideal.—C. E. P. Many thanks; all of those are coming. We have a whole bookful ready. What we should like to have noticed would be any omissions in the alphabetical list. "Spank" for "whip," as you say, and "whip" for "beat" (in the sense of "conquer"). "Begin" ("doesn't begin to") is the only one in your list which needs noting.—F. C. Have not seen the tablet or the Rev. Dr. Howley's argument about Taurus and the Deluge. At a venture—bosh.—J. A. Ollard. You are an old friend of Knowledge; but as for being "fair," I have had four years of hard work on Knowledge for others entirely; I know of no law of fairness which forbids my easing up a little. If but a few of our friends had done each but a little to help, I might have gone on. —Astro. 1. I don't know; if you were to look up the last edition (which you can do quite as readily as I) you would see. 2. Nobody believes now in a cool solar nucleus. 3. Not having the latest edition, cannot say; but as it was published several years after Herschel's death, I presume he made no such alteration in it.—Isabella Terrell. Thanks. Letter and form of the tracings shall appear.—Commentator. We send on no MS. to correspondents, in that way: have not "G.'s" address, even. As regards the admiration you mention, you must be mistaken: I have never expressed any such feeling.—H. E. Brandon. See notices to correspondents.—M. Volk. Cannot devote space to your purpose.—A. S. Barnes. Your criticisms justified. Albeit cause and effect are really interchanged. Thus clouds are caused by lowering of temperature; but they also cause the temperature to fall in places which they shadow—in the summer-time. And so on.—Thomas Willcocks. Quite agree with all you say. Those have been my views for many years.—R. Lewins. Glad you are pleased.—Edward Norris. Many thanks. Book has not yet been forwarded to me at York, but doubtless will soon be.—P. J. Beveridge. I really cannot. Readers object, and very properly, to the introduction of letters which only indicate how and in what degree the writer has misconceived some matter. That is all your letter amounts to. Darwin admitted that one cannot always see in what way the balance in the struggle for life may be affected by some special peculiarity. But admitting this is not giving up the belief that when the balance of advantages *is* affected, however slightly, the circumstance will tell in the long run.—F. Pullinger. A short answer would be worth nothing.—H. O. C. It might be so, if it were so; but it is not so. You never saw cattle and trees magnified by a fog. You thought you did, but you did not. The illusion is well known. You see the objects with a certain amount of distinctness, only when they are much nearer then as usually so seen. Hence they occupy a larger space on the retina, and you suppose they are magnified. If the fog suddenly cleared you would not find them grow less, by a hair's breadth. Magnification by a convex lens is quite another thing.—J. Your experience, I find, agrees with mine. Albeit, those expressions may still be called Americanisms—except "bilin'," which is too commonly heard in England to be less English than American. Words and expressions which are localisms or vulgarisms on this side, but used everywhere in America, may, I think, fairly be called Americanisms. Locke is a man who wrote on the Mind: but no matter.—E. A. Gepp. Most certainly we shall keep up our Whist. —H. A. Miles. Thanks.—A Subscriber from the First. I think with you. But he is a *well-meaning* nuisance.—J. G. G. Do not know.—J. G. S. The nebula is not near any star shown in those elementary maps. It is shown in my "Stars in their Seasons."—R. Lewins, M.D. "It will go near to be thought so, shortly."—A Subscriber. Some say the yolk, others the white. I should say the yolk myself. As to human hair growing after death, I have heard stories to that effect. Safest not to believe them.

Next year's British Association is to be held in Birmingham, and that for 1887 in Manchester, the latter having been chosen in preference to Bath.

We are pleased to notice that there is considerable prospect of the system of train-lighting on the London, Brighton, and South Coast Railway, which was described in Knowledge, No. 174, p. 168, being shortly extended. Its many advantages are apparent. We hear that the system tried on the Great Eastern was an expensive one, inasmuch as seven engines had to be fitted with dynamo, &c., to maintain a single train, consequent on the fact that while carriages can be kept constantly running, engines cannot.

Our Chess Column.

By Mephisto.

ILLUSTRATIVE GAME No. 11.

A COMMON error, even amongst many good players, occurs when receiving the odds of Pawn and move or Pawn and two moves from a first class player. They imagine that by avoiding hasty attacks, and merely playing a steady game, they will be able to win finally with the extra Pawn. This is, however, not so, and the belief is soon dispelled after a little experience of first-class play. Purely defensive play or heedless attacks are both equally weak. When receiving the odds of Pawn and moves, it is quite correct, immediately after the Opening moves, not to make an attack against any particular point. But the thing is *to attack the position as a whole.* This advice holds good, more or less, for every Opening. For if your own pieces are well developed and the opponent's position is cramped, then surely enough favourable opportunities for a specific attack will soon be found. But inactivity in the Opening, as in the following game, will enable the stronger player to get over the disadvantage of position, and take the attack in hand himself.

Game played September 12 at the odds of Pawn and two moves:

Remove Black's King's Bishop's Pawn.

White. F. J. Lee.	Black. J. Gunsberg.
1. P to K4	
2. P to Q4	P to KKt3
3. B to Q3	P to Kt3
4. Kt to KB3	B to KKt2
5. P to B3	B to Kt2
6. Castles (*a*)	P to K3
7. Kt to R3 (*b*)	Kt to K2
8. Kt to KKt5 (*c*)	Castles
9. P to KB4	P to B4 (*d*)
10. B to K3	P to KR3 (*e*)
11. Kt to R3 (*f*)	P to Q4
12. P to K5 (*g*)	P to B5
13. B to QB2	P to R3 (*h*)

Black.

White.

14. P to KKt4 (*i*)	QKt to B3
15. Q to K sq.	P to QKt4
16. Q to R4	Q to K2
17. QR to Q sq. (*j*)	R to B2 (*k*)

White. F. J. Lee.	Black. J. Gunsberg.
18. R to B2	P to Kt5
19. Kt to Kt sq.	QR to KB sq.
20. P to Kt3	P to QR4
21. P × BP (*l*)	QP × P
22. Kt to Q2 (*m*)	Kt to Q4 (*n*)
23. R to K sq.	Kt × B (*o*)
24. R × Kt	P × P
25. R × P	Q × P (*p*)
26. R × P	Q to K6
27. R to K4 (*q*)	Q to R2 (*r*)
28. B to Kt3	R to K sq.
29. Q to Kt3	

Black.

White.

	Kt to Q5
30. R to K sq.	R to B2 (*s*)
31. P to B5	R to B8! (*t*)
32. Q to K3	Kt to B6 (ch) (*u*)
Resigns	

Notes.

(*a*) Here we have the first illustration of our above remark. There is nothing to be said against Castling in itself, except that it is not a sufficiently active move, and gives Black time to develope. By not Castling too soon, White reserves himself the chance of attacking the weak K's side and Castling QR. Thus, for instance, 6. B to KKt5 would develope a piece and at the same time prevent Black from playing P to K3. Should Black attempt to play P to KR3 in reply to 6. B to KKt5, then White will retire his B to R4, but Black will have a dangerously weak spot on KKt3, and there is nothing to prevent White from reaching it after he plays P to K5.

(*b*) Giving Black more time; a highly important element in this game.

(*c*) His idea being to advance the KBP. But as he may have to retire that Kt later on, it is obvious that it would save a move to play P to KB4 before playing out the Kt to KB3.

(*d*) Black has nothing to fear from White playing P to KB5. Black utilises the first moment after having secured his K to attack White's centre, White, by defending it, gives Black time for further development.

(*e*) Driving the Kt back, in order to be able to move his KP or

QP freely. Black will be better able now to defend his KKt3 if attacked.

(*f*) White's idea being not to put his Kt in the way of his Q or R. But Kt to B3 would probably have been better, as from B3 he could, if feasible, play Kt to R4 later on, with a good chance to press on the weak spot on Black's KKt3.

(*g*) A tempting move, but the following play would have simplified the game in White's favour:—12. P × BP, P × KP. 13. B to B4, Kt to Q4. 14. B × Kt, P × B. 15. P × P, P × P, &c.

(*h*) To prevent the Kt from reaching the commanding position on Q6 viâ QKt5, also with a view to support the advanced P on B5 against P to QKt3 with P to Kt4.

(*i*) If 14. Q to Kt4, Kt to B4. 15. B × Kt, KtP × B.

(*j*) Some very interesting combinations might have resulted from White's move of 17. P to B5. If Black had replied to this with 17. P to Kt4, White might have continued 18. B × P, P × B. 19. Kt × P, and wins. But if 17. P to B5, KP × P. 18. B × RP, P × P. 19. Kt to Kt5, Kt to B4. 20. B × Kt, P × B, &c.

(*k*) Partly with the object of doubling the Rooks on that file, also to forestall P to B5, P × P, B × RP, as Black, after B × B, Q × B, would have a good reply in R to R2!

(*l*) White was not prudent in taking this P, as thereby Black's QB comes into good play, a chance much desired by Black.

(*m*) White, feeling himself driven back inch by inch, seeks again to reach Q6 with his Kt, only he is one season behind.

(*n*) Taking the initiative in the attack, White cannot play Kt × P, as Black would win a piece by B to R3.

(*o*) Black has left his P on Kt3 en pris, it is, therefore, all important for him not to lose the move. It was difficult to say—as it often happens in similiar positions—whether P × P or Kt × B is better. Kt × B dissolves White's centre, the object aimed at by Black.

(*p*) Black having now opened up the game, is—mindful of its being a game at odds—willing to run some risk for the sake of an attack.

(*q*) In reply to 28. B × P Black would have had nothing better than Q to K8 (ch). 29. Kt to B sq., R to Q2, &c.; perhaps White was unnecessarily afraid of this continuation.

(*r*) Wishing to keep the Rook pinned, with the possibility of bringing the Kt into good play, viâ Q4.

(*s*) Black is now thorough master of the position, and prepares a surprise for White.

(*t*) In this very curious position both Rooks are pinned now. Black threatens to win the Queen by Kt to K7 (ch). White has no good reply. If 32. K to B sq., B to R3 wins, or if 32. B to Q sq., R × B wins.

(*u*) An elegant *coup de grâce*. If 33. Kt × Kt, Q × Q; or if 33. R × Kt, R × R (ch) wins.

Our Whist Column.

By "Five of Clubs."

Returning Partner's Lead.*

RETURN your partner's lead at once if you have no good suit of your own; but, with a suit which you have reason to think as good as his, you should show your own suit before returning his. If the player on your left has shown extreme weakness in your partner's suit, it is better, usually, to let your partner wait till he gets the lead himself, as it is obvious that the strength lies between him and the opponent to your right; so that your partner, if made third player, will be at a disadvantage.

In returning, *play the higher of two cards, the lowest of three or more.* This is a most important rule. Pay especial attention, also, to the card your partner returns in your suit. If he returns a card which you know (by the play) to be not the highest left in his hand, you may be sure, if he is a careful player, that besides that higher card he holds at least one other.

The exceptions are three. First, if, when you return your partner's suit, you have the best card in the suit, you should lead the best; secondly, with second and third best and a small one, you lead the second best, not the small card; thirdly, with second best and a small one, you generally lead the small one. In the third case, however, it is safer as a rule to refrain from leading back to your partner. If he leads the second time, and the best is on your right, your second best makes. Yet, when your partner's lead indicates great length, it is more important to clear his suit and to avoid blocking it, than to make your second best; in this case you lead second best, and, if it is taken by the best, you still have a small card to lead with a third time, should you have the opportunity; of course, if you are sure you will not have such an opportunity, having no card of re-entry, all you can gain by leading the second best is to clear, or help to clear, your partner's suit.

* From the Author's forthcoming work entitled "Home Whist."

In trumps the rule for returning the higher of two cards, the lowest of three or more, is even more important than in plain suits. But in all suits it should be carefully followed.

Discarding.

When you have to *discard*—that is, when you cannot follow suit—your natural course is to play the card you can best spare. And usually, for the same reason that your longest suit is usually the one you most value and in which you have the greatest reliance, your shortest suit is the one you value least, and from which, therefore, you make your first discard. Still it is manifest that often mere length affords no criterion of value. If you have four small cards in one suit and King or Queen with but one or two *guards* (or small cards) in another, you would prefer to discard one of the four small cards, which are alike worthless, to discarding one of the guards of the King or Queen, which may lead to the downfall of the royal card before the enemy's Ace.

The general rule, then, for the first discard is, that *while as yet the relative strength of the hands is unknown* it should be from your shortest suit unless that suit needs protection, in which case you discard from the suit of least value. This rule may be put in a form which I have often found convenient in teaching Home Whist—so long as you do not know how the strength of the hands lies, let your first discard be from the suit you would least like your partner to lead.

When strength, and here I refer specially to trump strength, is declared in your favour, this rule should always be obeyed.

But, when strength in trumps is clearly against you, cautious play is necessary. The enemy are manœuvring, or will presently manœuvre, to bring in a long suit. It is essential, therefore, that you should retain, as long as you can, any command you may have in their strong suits. Therefore you must avoid discarding from those suits, if, by so doing, you dangerously reduce the number of guards protecting whatever high cards you may have in them. It is safer to discard from your own longest suit, in which you are usually well protected. If trump strength is heavily against you, you lose nothing by discarding from your long suit, simply because you have no chance of bringing in the complete suit.

Therefore we have this general rule—*when trump strength is against you*, your first discard should be from that suit which you can most safely unguard. As this is usually your longest suit, your partner has some reason for inferring that your first discard is from your best suit when trump strength is declared against you. But I reject as utterly unsound the doctrine that your first discard in such a case should be regarded as directing your partner to lead the suit from which you have discarded. It is not a sound rule that you should always discard from your longest or your best suit when the enemy have the trump strength. If you have two or three worthless cards in one of the enemy's suits, you ought to discard from them, seeing that they can do you no possible good. It is a misfortune for you that you should have to discard from your best suit, as too often happens when the enemy are strong in trumps; it is a misfortune also to have a suit of two or three worthless cards; but it is the height of absurdity, if the second misfortune has befallen you, to add the other, by discarding from a strong suit when you have really worthless cards to throw away. You must remember, however, that small cards in your partner's suit are by no means worthless, as you may want one or more of them to lead to him with.

The modern doctrine of uniformity at Whist is sound enough, as a general doctrine, but this doctrine has run mad when it teaches, as some of its modern exponents make it teach, that for the sake of uniformity good cards should be thrown away and worthless cards retained. Of course it would be a great convenience if we could have such a rule for discarding against trump strength as would render judgment unnecessary, and enable your partner at once to decide in which suit you have most strength. But, as no such rule can be adopted without causing occasional offence against the great Whist rule, that "You should play to win," room must still be left for judgment in discarding against strong trump hands.

Observe, however, that if you see clearly that you will have to discard more than once, with strength in trumps against you, and that one of these discards must be from your best suit, then let your *first* discard be from that suit.

In all cases, observe that the first discard is the directive one. Thus when nothing is as yet known about the trump strength, or when trump strength is decidedly on your side, the first discard shows your weakest suit, and directs your partner to one or other of the two remaining plain suits as your best.

When you have to discard from a suit in which you have entire command, discard the best. Never discard the second best of a suit unless you hold it single. If you hold alone the best of a suit in which your partner has entire command, and it is certain that he will presently get a lead in the suit, get rid of the card at the first opportunity, or it will block his suit.

(To be continued.)

Our Inventors' Column.

We give here, week by week, a terse description of such of the many inventions as we think may be of use to our readers. Where it is possible, the number of the patent is quoted, to enable those who desire fuller information to procure the specification from the Patent Office in Cursitor-street, Chancery-lane. We shall, generally speaking, confine ourselves to the more recent inventions; but it often happens that an article comes under our notice which, although not quite novel, is worthy of mention for its utility and ingenuity. In such a case we should not hesitate to refer our readers to it. And while we thus increase the interest of our pages, we at the same time assist the inventors by giving greater publicity to their inventions (KNOWLEDGE *being a popular magazine*) *than is accorded by the most excellent trade journals.*

IMPROVEMENTS IN BRINSMEAD PIANOS.

PIANOFORTES have hitherto been regarded in a double aspect—both as musical instruments and as articles of household ornamentation; and we make bold to say that, with many people, the latter consideration has predominated to such an extent as to give rise to the practice, on the part of unprincipled manufacturers, of enclosing worthless mechanisms—from a musical point of view—in cases constructed simply with a view to their effective appearance. The purchasers of these "musical boxes" soon discover, however, that they have sacrificed their sense of sound to their sense of sight, but too late in many cases to remedy the evil; for pianoforte-buying with most people is an affair of once for all time rather than an everyday occurrence.

With the idea of remedying to a great extent this state of things, the well-known firm of Brinsmead & Sons have introduced, and are exhibiting at the Inventions Exhibition, an improvement in the construction of pianos which cannot fail to commend itself to all concerned. The pianoforte is now manufactured by them and shown complete, irrespective of the cabinet-work, which is altogether a subsidiary after-consideration. It is not merely the ordinary "Brinsmead" previous to encasement that is exhibited, however, but a complex development of the latest inventions of the firm, resulting in a mechanical structure challenging approval or condemnation on its merits as a tone-producer alone, an inspection and study of which convinces one that a forward step has been taken by the manufacturers in the interests of the musical art. The illustrations given herewith show the front and back view of their Patent Consolidated Iron Piano; an examination of these will present a better idea of the mechanical improvements effected than could be afforded by mere verbal description.

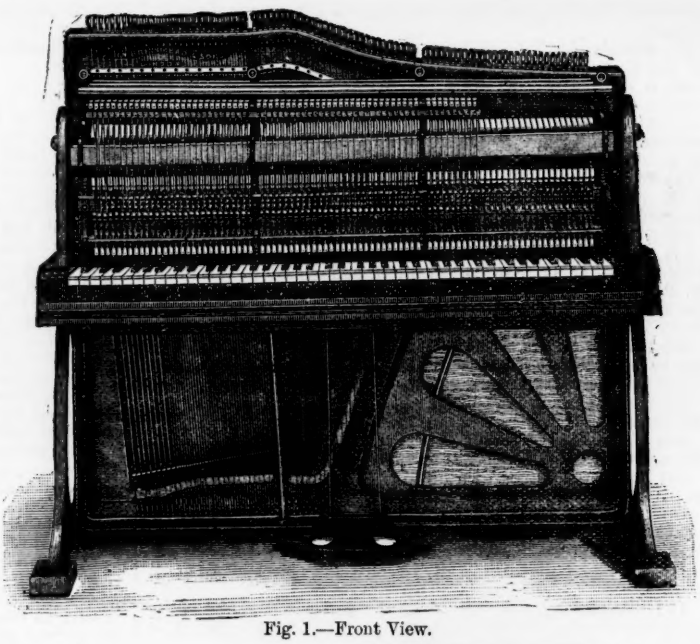


Fig. 1.—Front View.

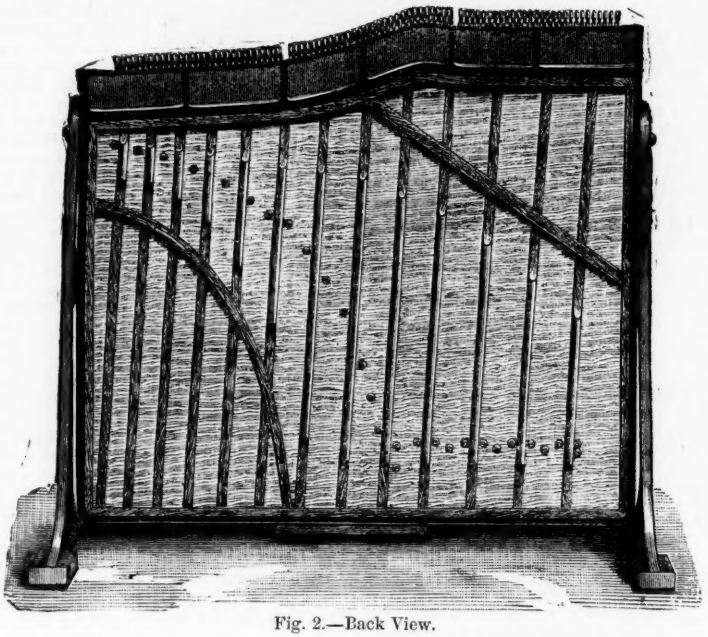


Fig. 2.—Back View.

Mr. R. A. Proctor's Lecture Tour.

Subjects:

1. LIFE OF WORLDS
2. THE SUN
3. THE MOON
4. THE UNIVERSE.
5. COMETS AND METEORS
6. THE STAR DEPTHS
7. VOLCANOES.
8. THE GREAT PYRAMID.

Each Lecture is profusely illustrated.

Arrangements are now being made for the delivery of Lectures by Mr. Proctor. Communications respecting terms and vacant dates should be addressed to the Manager of the Tour, Mr. JOHN STUART, Royal Concert Hall, St. Leonards-on-Sea.

Sept. 21, 22, Harrogate; Sept. 23 24, 25, Ilkley; Sept. 28, 29, Derby.

Oct. 2, Chester; Oct. 3, 17, Malvern; Oct. 6, 9, 12, 13, Plymouth; Oct. 7, 10, 14, 16, Torquay; Oct. 19, 22, 28, Salisbury; Oct. 21, 26, 29, Southampton; Oct. 23, 27, 30, Winchester. Oct. 31, Marlborough College.

Nov. 2, Chester; Nov. 4, Burnley; Nov. 9, Stafford; Nov. 10, Streatham; Nov. 12, Middlesbrough; Nov. 17, Darwen; Nov. 19, Saltaire; Nov. 25, 28, Bath; Nov. 26, 30, Clifton.

Dec. 2, 5, Bath; Dec. 4, Clifton; Dec. 7, 8, 9, Croydon; Dec. 11, Chester; Dec. 16, 17, 18, 19, Leamington.

Jan. 12, Hull; Jan. 15, Stockton; Jan. 23, Bradford.

Feb. 3, Alexandria; Feb. 5, Chester; Feb. 6, 20, Malvern Feb. 9, 12, 19, Cheltenham; Feb. 10, Walsall; Feb. 15, Upper Clapton; Feb. 18, 25, London Institution. Feb. 22, Sutton Coldfield.

March 1, 3, 5, Maidstone.